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מוסד ויצמן למדעים במדעי הטבע ובטכניקה בישראל · ירושלים

BULLETIN OF THE RESEARCH COUNCIL OF ISRAEL

Section B BIOLOGY and GEOLOGY

Bull. Res. Counc. of Israel. B. Biol. & Geol.

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BULLETIN OF THE RESEARCH COUNCIL OF ISRAEL

MIRIAM BALABAN, *EDITOR*

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יוצא לאור ע"י
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p. 113, line 1: *for* "carrying" *read* "varying".

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THE HALICTINAE (HYMEN., APOIDEA) OF ISRAEL
I. GENUS *HALICTUS* (SUBGENERA *HALICTUS* S. STR. AND *THRINCOHALICTUS*)

PAUL BLUETHGEN

Naumburg a/Saale

ABSTRACT

27 species of the genus *Halictus* are reported as occurring in Israel; 11 more species occurring in neighbouring countries may be expected to occur here, too.

A new subgenus **Thrincohalictus** Blthg. is erected for *Halictus prognathus* Pérez. New species: *Halictus* **subsenilis** ♂♀, *H.* **galileus** ♂, *H.* **semiticus** ♂♀, Description of new sexes: *Halictus fatsensis* Blthg. ♀, *H. tuberculatus* Blthg. ♀, *H.* (*Thrincohalictus*) *prognathus* Pér. ♂.

In his paper "Stammesgeschichte der Hautfluegler", C. Boerner (1919) established in the subfamily Halictinae of the family Halictidae 3 tribes: *Nomiini* (including the genera *Nomia* Latr., *Augochlora* Sm., *Agapostemon* Guér., etc.), *Halictini* (including the genera *Halictus* Latr., *Sphecodes* Latr., etc.), and *Nomiidini* (including the genus *Nomioides* Schck. only). In the present paper the genera *Halictus* Latr. (sensu latiore), *Sphecodes* Latr., and *Nomioides* Schck. only are dealt with.

Halictidae from Israel are mentioned in the following papers: Alfken (1935, 1938), Bodenheimer (1937) and Mavromoustakis (1939).

Alfken's earlier paper is based mainly on the rich material collected by E. Enslin in 1927 (20—28.IV) and by E. Enslin and R. Stich in 1934 (19—26.IV); some species captured previously by O. Schmiedeknecht are mentioned besides. In this paper the author enumerates 25 species of *Halictus*, one of *Sphecodes* and none of *Nomioides;* the determination had been done for the most part by P. Bluethgen. In Alfken's second paper the genera *Halictus*, *Sphecodes* and *Nomioides* are not mentioned at all.

In his "Prodromus", Bodenheimer registers 47 species of *Halictus*, 7 species of *Sphecodes*, and 3 of *Nomioides*. Most of the material collected had been sent for identification to the Berlin Zool. Museum and had been worked out by Bluethgen; however, some species listed by Bodenheimer apparently had been determined by other entomologists.

Mavromoustakis mentions 7 species of *Halictus* collected by J. Glimcher (Jerusalem).

Since that time the investigation of the Aculeata of Palestine has progressed well, as H. Bytinski-Salz (Tel Aviv), J. Wahrman (Jerusalem) and F. Palmoni (Deganya) have been collecting further abundant material. Likewise the Dutch entomologist P. M. F. Verhoeff (den Dolder) succeeded in increasing the number of species durnig a collecting trip to Israel in 1951. I have also utilized captures made by the German microlepidopterologist H. Amsel in 1930, and by the late Reverend F. D. Morice (Woking). All Halictinae gathered by these entomologists have been examined by me.

Received August 15, 1954.

A list of abbreviations used will be found at the end of this paper. The species occurring in Israel are marked by an asterisk (*), in contradistinction to those which are known from adjacent territories only, but might also be found in Israel in the future.

Genus *Halictus* Latr., 1804 (s. l.)

(Genotype: *Halictus quadricinctus* [Fabr., 1776], fixed by O. W. Richards, 1935)

Robertson (1902) divided the genus *Halictus* Latr., 1804, into 4 genera: *Halictus* Latr. (restricted to the black or green species with distally banded tergites), *Lasioglossum* Curtis, 1833 (genotype: L. *tricingulum* Curtis, 1833 = *Melitta xanthopus* W. F. Kirby, 1802 = *Halictus xanthopus* [K., 1802], *Evylaeus* n.g. (genotype: *Halictus arcuatus* Robts., 1893), and *Chloralictus* n.g. (genotype: *Halictus cressonii* Robts., 1890), characterized by him as follows:

(1) Forewing with veins beyond IV_3 (= 1st recurrent vein) obsolete; cells III_4 and III_5 (= 3rd and 2nd submarginal cells) subequal. No apical pubecsent fasciae. . . . . (2)

— Forewing with veins beyond IV_3 not obsolete; cell III_4 at least nearly twice as long as III_5. Labrum at apex protruding, laterally compressed, pectinate. Black or dullish green; segments of abdomen with apical pubescent fasciae; cell III_{1+2} (=marginal cell) subappendiculate; vein IV_3 beyond the middle or near end of cell III_5; hind knee plate lanceolate; vein *a* (=basal vein) rather suddenly bent at lower third. . . . . *Halictus* Latr.

(2) Forewing with vein III_5 (=2nd submarginal) not obsolete; cell III_{1+2} subappendiculate; vein IV_3 near end of cell III_5; hind spur finely serrate; insect unusually smooth and opaque; segments 2—4 with basal pubescent fasciae; metathorax rather smooth; cheek broad; ♂: joint 3 of flagellum a little shorter than 2+1. . . . . *Lasioglossum* Curt.

— Forewing with vein III_5 also obsolete; vein IV_3 near end of cell III_5 or interstitial with vein III_5. ♂: joint 3 of flagellum = 2+1 or longer than these. . . . . (3)

(3) Head and thorax dull greenish or bluish. . . . . *Chloralictus* Robts.

— Head and thorax black; ♂♂ with basal pubescence always have the metathorax strongly rugose . . . . . *Evylaeus* Robts.

Robertson (1918) later separated:

1. From *Halictus* Latr. 2 new genera: *Seladonia* n.g., with *S. seladonia* (F.) (*Apis seladonia* Fabricius, 1794 = *Halictus subauratus* [Rossi, 1792]) as genotype, ". . . including rather small, greenish species as *S. fasciata*, *flavipes*, etc.", and *Odontalictus* n.g., with *O. ligatus* (*H. ligatus* Say, 1837 = *H. armaticeps* Cresson, 1872) as the genotype, ". . . on account of the cheeks of the ♀ protruding into a tooth".

2. From *Lasioglossum* Curt. a new genus: *Curtisapis* n.g., with *C. coriacea* (*H. coriaceus* Sm., 1853) as genotype, ". . . on account of the serrate hind spurs of the ♀♀; the ♀♀ being more opaque and smaller than in *Lasioglossum*. The genus includes also *C. fuscipennis* (Sm., 1853) and *forbesii* (Robts., 1890)".

These 6 new genera of Robertson's, however, have always been treated by T. D. A. Cockerell as subgenera of *Halictus* Latr., while the European taxonomists, R. C. L. Perkins, O. W. Richards, I. Perez, I. Vachal, I. D. Alfken, H. Friese, I. Noskiewicz, paid no attention at all to the new classification.

C. D. Michener (1944, 1951) admitted as genera only *Halictus* Latr. (with 2 subgenera, *Halictus* and *Seladonia* Robts.) and *Lasioglossum* Curt. (with 7 subgenera, of which only 3, viz. *Lasioglossum*, *Evylaeus* and *Chloralictus*, come into question for the Palaearctic zone). So far as I can see, till now only the late Pittioni (1950) has

adopted the classification of Michener, but without the subgenera *Seladonia* and *Chloralictus*.

I cannot agree with this classification, since it seems to me to be partly superficial and partly, as concerns the Palaearctic fauna, insufficient. In the present paper I call attention only to the following facts:

1. The subgenus (formerly genus) *Chloralictus* is a sort of "Procrustes' bed" into which have been squeezed by the American authors all totally or partly green or bluish "*Lasioglossum*" species, without any regard to their natural affinities and their structural characteristics. I have before me 10 nearctic species of "*Chloralictus*" determined by Viereck, Crawford, Cockerell and Gr. Sandhouse. Apart from the colouring, the subgenotype *Cressonii* (Robts., 1890) is evidently a true *Evylaeus*, agreeing with *Evyl. arcuatus* (subgenotype of *Evylaeus*) in the stout shape of the body and in the structure and the coarse sculpture of the median segment. The same is the case for *albipennis* (Robts., 1890), *reticulatus* (Robts., 1892) and *nymphaearum* (Robts., 1895) ♀♀. On the other hand, such species as *zephyrus* (Sm., 1853), *viridatus* (Lov., 1905), versans (Lov., 1905) and *mesillensis* Ckll., 1898, belong to groups agreeing well with certain palaearctic species, e. g. *aureolus* Pér., 1903, *albovirens* Pér., 1895, and *leucopus* (K., 1802).

It is quite erroneous to unite the more or less green species of *Halictus* s. l. in a separate taxonomic group. As I have discussed long ago (Bluethgen 1923), all green Halicti belong to certain groups of "black" species and are frequently connected with these by transitions of colouring. For example: *chalcodes* Brullé, 1840, belongs to the *sexnotatulus* Nyl., 1852, group; *morio* (F., 1793), *smeathmanellus* (K., 1802) and their allies — to the *calceatus* (Scop., 1763) group; *leucopus* (K., 1802) — to the *pauperatus* Brullé, 1832, group; *laetus* Brullé, 1840, — to the *nitidiusculus* (K., 1802) group; *arabs* Pér., 1907 — to the *limbellus* Mor., 1876, group; *croceipes* Mor., 1876 — to the *marginellus* (Schck., 1853) group; there exists also a hitherto unpublished Turkestan species (*filipes* n. sp. i. litt.) that combines the general structure and sculpture and, moreover, the peculiar shape of the fore tarsi of *croceipes* (Mor.) (see Bluethgen 1931) with a deep black integument. The most striking and the most instructive fact, however, is that *viridis* Brullé, 1840, from the Canary Islands, occurs in a green form (*viridis*) and a black one (*unicolor* Brullé, 1840).

In the subgenus *Seladonia* the situation is similar. Most of the groups included in it are closely connected with "black" species or with black and red ones, e. g. *nasica* Mor., 1876, belongs to the *vestitus* Lep., 1841, group; *radozkovskii* Vach., 1902, and its allies — to the *mucoreus* (Ev., 1852) group; *desertorum* Mor., 1876 — to the *subauratus* (Rossi, 1792) group.

For these reasons the subgenus *Chloralictus* Robts. cannot be maintained but must be regarded as a synonym of *Evylaeus* Robts.

2. The generic classification of *Halictus* s. l. constitutes a very delicate problem. Granted that the Halicti proper (sensu Robertson and Michener) including *Seladonia* are clearly separate from *Lasioglossum* Curt. and *Evylaeus* Robts., but, on the other hand, it should be understood that *Lasioglossum* (sensu Robertson and Michener) comprises no less different and contradictory divisions than formerly *Halictus* s. l. did. For example, the relationship between the *politus* (Schck., 1853) or the *lucidulus* (Schck., 1859) groups and the genotypes of both *Lasioglossum* (*xanthopus* [K., 1802])

and *Evylaeus* (*arcuatus* [Robts., 1893]) is not at all closer than that between the same groups and the genotype of *Halictus* (*quadricinctus* [F., 1776]); and the same is the case in many other groups.

In the present paper, therefore, the treatment of *Halictus* is conservative. It is recognized that fundamental changes will have to be made in the future, but it is believed best to wait until a comprehensive revision can be carried out, in order to ensure stability.

Subgenus *Halictus* Latr.

quadricinctus group

**Halictus quadricinctus* (F., 1776)

1776, *Apis quadricincta* Fabricius, Gen. Insect., p. 247. Loc. typ.: Denmark. — 1805, *Halictus quadristrigatus* Latreille, Hist. nat. Crust. & Insect., **13**, p. 364.

Jerusalem, ♂♂ ♀♀, 22.V—15.VI; Kfar 'Ivri, ♂, 7.VI; Beeri, ♂♂, 1.VI; Gezer, ♂, 28.VI; Gvulot, Urim, ♂♂ ♀♀, 28.V; Binyamina, ♂♂ ♀♀, 12.IV—15.V; Alonim, ♀♀, 7.V; 'Ein Gev, ♀, 5.IV; Mishmar Hayarden, ♀, 12.V; Jordan (Dan), ♀, 11.V; (ByS, P., Bo.).

Most of the specimens represent a transition to the var. *aegyptiaca* Friese, 1916, by the broadened and generally entire abdominal bands, but the ♂♂ have the flagella black above, not extensively testaceous as in typical specimens of var. *aegyptiaca*.

Parasite: *Sphecodes gibbus* (L.).

Distribution: Europe (except Great Britain and Scandinavia), Asia, North Africa.

Halictus quadricinctus brunnescens (Eversm., 1852)

1852, *Hylaeus brunnescens* Eversmann, Bull. soc. nat. Moscou, **25**, p. 36, ♀. Loc. typ.: east of Orenburg district. — 1902, *Halictus duplocinctus* Vachal, Rev. Russe d'Ent., **2**, p. 225. Loc. typ.: Askhabad. — 1916, *Halictus quadricinctus* (F.) var. *maximus* Friese, Dtsch. ent. Z., p. 29—30. Loc. typ.: Sarepta. — 1903, *Halictus magnificus* Nurse, Ann. Mag. Nat. Hist., (7) **11**, p. 541, ♀. Loc. typ.: Kashmir.

Distribution: south-east Russia, Transcaspia, Turkestan, Kashmir, Baluchistan (Quetta).

rubicundus group

Halictus rubicundus (Christ, 1791)

1791, *Apis rubicunda* Christ, Naturg. d. Jns., p. 190; Taf. 16, Fig. 10.

Distribution: Eurasia. Has been found in Asia Minor, near Kerasonda (Kieresuen) (M. B.).

sexcinctus group

**Halictus sexcinctus* (F., 1775)

1775, *Apis sexcincta* Fabricius, Syst. ent., p. 387, ♂. Loc. typ.: Southern Europe.

Binyamina, ♀♀ ♂♂, 7—27.VI (ByS); ♂♂ ♀♀: Nahariya, 7.V—19.VI, Rosh Haniqra (Ras el Nakura), 9.VI, Tiberias, 12.IV (ByS), (V.); all fresh specimens.

Distribution: Europe (except Great Britain), Asia Minor, Armenia, Transcaucasia; absent in North Africa.

**Halictus berlandi* Bluethg., 1936

1936, Mitt. Zool. Mus. Berlin, p. 270, ♂♀. Loc. typ.: Guelek (Taurus).

Jerusalem, ♂♂ ♀♀, 4.IV—28.X (fr. sp.) (ByS); Jerusalem (Mt. Scopus), ♂♀, 4—11.X, on *Varthemia iphionoides* and *Inula viscosa* (W.); Beit Hakerem, 1 ♂, 7.XII (fr. sp.) (ByS); Kfar 'Ivri, 1 ♀, 11.VI (ByS); Qiryat 'Anavim, 1 ♂, 7.IX.31, ♀♀, 1.IX.30 (Bo.).

♀ var. tibiis tarsisque obscure rufis: Eilon, 1 ♀, 18.IV (ByS); Sejera, 1 ♀, 10.VII (ByS); Haifa, 1 ♀, 6—8.V (V.).

Distribution: Asia Minor (Adana, Taurus, Amanus [Iaribaschi]), Syria (Nahr el Hussein near Tartous, Beirut, Zahle).

Halictus cochleareitarsis (Dours, 1872)

1872, *Lucasius cochleareitarsis* Dours, Rev. et Mag. Zool., (2) **23**, p. 352, T. 28, Fig. 4, ♂. Loc. typ.: Montpellier. — 1910, *Halictus anomalipes* Lebedev, Rev. Russe d'Ent., **10**, p. 310, ♂. Loc. typ.: Elisabethpol.

Listed by Bodenheimer, but probably a misidentified specimen of *berlandi* ♂. The female described by me (Bluethgen 1936) is very similar to *Hal. fulvipes* (Klug, 1817) ♀.

Distribution: Southern and Eastern Europe (Spain, south France, Italy, Dalmatia, Greece (including islands), Macedonia, Bulgaria, Dobruja, the Ukraine), Asia Minor (Akchehir, Taurus, Amanus), Transcaucasia (Elisabethpol).

scabiosae group

Halictus scabiosae (Rossi, 1790)

1790, *Apis scabiosae* Rossi, Fauna Etrusca, **2**, p. 105, ♂. Loc. typ.: Italy.

Recorded by Bodenheimer, but certainly misidentified (=*berlandi* ♀?).

Distribution: this species is a strictly Western Mediterranean one. The easternmost localities I know of are Istanbul, Polish Tshifflik on the Bosporus and Keschisch Dagh near Brussa. It is absent in Egypt. It is true F. D. Morice (1921) has recorded *scabiosae* from northwest Persia (Qazvin) and Mesopotamia (Amara), but I doubt whether the identification is correct. Very often the fully banded southern specimens of *Hal. sexcinctus* (F.) are taken for *scabiosae*.

Halictus fulvipes (Klug, 1817)

1817, *Hylaeus fulvipes*, Klug in Germar, Reise nach Dalmatien, **2**, p. 265, ♂. Loc. typ.: Spalato (Dalmatia).—1872, *Halictus sexcinctellus* Dours, Rev. et Mag. Zool., **23**, p. 305, ♀. Loc. typ.: Algeria.

Recorded by both Alfken ("Jericho 1927") and Bodenheimer. The specimen in question is to be found neither in coll. E. nor in coll. A.; doubtless a misidentification.

Distribution: a Western Mediterranean species; it occurs neither in Egypt nor in Asia Minor.

**Halictus holtzi* (W. A. Schulz, 1906)

1906, *Halictus* (*Lucasius*) *holtzi* W. A. Schulz, Spolia Hymenopterologica, p. 49, ♂♀. Loc. typ.: Assitaes (Crete). — 1921, *Halictus asiaeminoris* Strand, Arch. Naturg., **87, A. 3**, p. 311, ♀. Loc. typ.: Asia Minor.

Common everywhere in Israel, so that it does not seem necessary to record localities in detail. The perimeter localities are: Daphne Oaks — Jericho — Beersheba, 10.III—9.X.

Distribution: this species is a strictly Eastern Mediterranean one and is widely distributed in Asia from Asia Minor to Baluchistan (Quetta) and Eastern Turkestan; in Europe it is found in the eastern region only, viz. Turkey, Greece, Bulgaria, Albania, Macedonia, Dalmatia, Tauria, the Ukraine, Dobruja; in Africa it is found only in Egypt.

Halictus squamosus Lebedev, 1910

1910, Rev. Russe d'Ent., **10,** p. 309, ♂. Loc. typ.: Gaudan (Kopet-Dagh). — 1916, *Halictus quadricinctus* (F.) var. *muruticus* Friese, Dtsch. ent. Z., p. 29 –30, ♀. Loc. typ.: Murut (Caucasus) and Ankara.

Distribution: this species, the finest of all Palaearctic *Halictus*, has been found, besides the typical specimens, in the Elbruz Mts. (Chehar Deh, 2000 m, 1 ♂, 31.VII, M.B.), in the Araxes valley (1 ♀, M. V.), near Konia (1 fresh ♀, 8.VIII.51, leg. coll. ByS; 1 ♀, 14.VII.52, coll. E.), near Beirut (1 ♀, coll. m.), and in the Lebanon (Bcharré, 1400 m, 1—4.VII.31, M. V.).

senilis group

**Halictus senilis* (Eversm., 1852)

1852, *Hylaeus senilis* Eversmann, Bull. Soc. natur. Moscou, **25,** p. 38, ♂♀. Loc. typ.: Orenburg. — 1895, *Halictus albarius* Pérez, Espèces nouv. Mellifères, Bordeaux, p. 51, ♀. Loc. typ.: not recorded (Ain Sefra?). — 1902, *Halictus bivinctus* Vachal, Rev. Russe d'Ent., **2,** p. 226. Loc. typ.: Askhabad.

Kallia (Dead Sea), 3 ♀♀, 15.II (ByS); Jordan (near Dead Sea), 28.V (ByS); Jericho (M. P.); Wadi el Kelt, 1 ♀ (E.); Jerusalem, ♀♀, 6.V.31, ♂♀, 31.V.31, ♂♀, 15.VI.31 (Bo.); Qiryat 'Anavim, ♂, 20.VII.31 (Bo.); Holon, ♂, 26.IV (ByS); Jaffa (M. P.); Tel Aviv, 1 ♀, 17.III (ByS); Ramat Gan, 2 ♀♀, 12.VI (ByS); Bnei Braq, ♂, 28.VI (ByS); Beersheba, 2 ♂♂, 23.VI, 27.VI (ByS).

The ♂♂ occur frequently with the anterior tergites coloured red to a greater or smaller extent (var. *fucosa* Mor., described in 1876 as species).

Distribution: south-eastern Russia; Turkestan, Baluchistan (Quetta), Mesopotamia, Transcaspia, Transcaucasia, Armenia, Asia Minor, Syria, Israel; Egypt, Tripoli, Algeria.

Halictus* **subsenilis n. sp. ♂♀. Figures 1—3.

This species is closely related to *senilis* (Eversm., 1852), *luganicus* Bluethg., 1936, *humkalensis* Bluethg., 1936, and *fatsensis* Bluethg., 1936. The ♂ can be distinguished:

a. from both *fatsensis* ♂ and *humkalensis* ♂ at a glance by the long and slender fore tarsi, which are shaped as in *senilis* ♂ and in *luganicus* ♂;

b. from *senilis* ♂ and *luganicus* ♂ thus:

subsenilis ♂

Body dark greyish brown.

Front, vertex, space between the ocelli, mesonotum and scutellum all with fine, erect hair, so that the sculpture is not hidden but is fully visible to a great extent.

As a rule only 1st to 4th tergites with an apical hair band, the band of the 5th, if present, less developed; the bands of the fore tergites more or less narrowed in the middle, not covering the entire apical depression, the bands

senilis ♂

Body deep black.

Front, etc., totally hidden by depressed tomentose broad hair covering the surface of the body entirely.

1st to 5th tergites with broad, entire apical bands, the bands covering totally the apical depression, even on the 1st tergite, the band on the 3rd tergite somewhat broader than a third of the tergite; basal half of the 1st tergite

conspicuously less broad than in *senilis*, that on on the 3rd tergite nearly as broad as a third of the tergite; 1st tergite in front with only a patch of fine tomentum on each side, basal band of 2nd tergite narrower, 3rd tergite without basal band, 1st and 2nd tergites not tomentose laterally; the structure of the tomentum conspicuously finer than in *senilis*.

Hair of both head and thorax whitish, pale ashy grey on vertex and mesonotum; bands of abdomen white, in quite fresh specimens with a slight brownish tinge.

Apical emargination of the 4th sternite forming a somewhat roundish obtuse angle.

tergite covered by thick tomentum, 1st and 2nd tergites tomentose along their sides, 2nd tergite with a broad basal band, 3rd with a narrower one.

Hair of both head and thorax white, vertex and thorax above in fresh specimens pale ochreous; hair bands of abdomen chalky white.

Apical emargination of the 4th sternite forming a regular very shallow concave bend.

subsenilis ♂ and *luganicus* ♂, which resemble each other at a glance so much that one might take them for conspecific, differ as follows:

subsenilis ♂

Apical emargination of the 4th sternite forming a somewhat roundish obtuse angle.

5th sternite with its apical edge very slightly concave.

Processus of the stipites with its outer stump as broad as the pectinate inner stump.

Punctation of both mesonotum and scutellum very fine and extremely dense, with the tiny intervals dullish.

Wings slightly greyish.

luganicus ♂

Middlemost third of the apical edge of the 4th sternite conspicuously concave.

5th sternite with both halves of its apical edge convex and forming between them a clear obtuse angle.

Processus of the stipites with its outer stump nearly half as broad as the pectinate inner stump.

Punctation of both mesonotum (especially behind) and scutellum conspicuously less minute and less crowded, with the narrow intervals polished and shining.

Wings hyaline.

The ♀ of *subsenilis* resembles extremely that of *humkalensis;* they differ only thus:

subsenilis ♀

Median segment nearly as long as the postscutellum; end of horizontal part broad, transverse; sculpture of the horizontal part very fine, granular, only laterally some very fine wrinkles can be seen.

Face = 78 : 82, conspicuously more convergent below, vertex less elevated; POL : OOL = 14 : 13, OVL much less than POL (9).

Punctation of the vertex above in the middle (seen from in front) rather dense (intervals partly narrower and partly wider than the points).

humkalensis ♀

Median segment conspicuously longer, nearly as long as the scutellum; end of horizontal part less broad, seen from above nearly roundish obtuse angled; sculpture of the horizontal part still more minute, and there are fewer wrinkles at the sides.

Face = 90 : 93, less convergent below, vertex somewhat broader and more elevated; POL : OOL = 11 : 16, OVL as broad as POL (12).

Punctation of the vertex above in the middle (seen from in front) conspicuously more scattered.

For the rest (as to shape, sculpture, hair and colouring) as in *humkalensis* ♀.

The ♀ of *luganicus* is not yet known. *subsenilis* ♀ differs from *senilis* ♀ as follows:

subsenilis ♀

Body dark greyish brown.

Hair of head and thorax pale yellowish grey, less abundant; bands of abdomen somewhat

senilis ♀

Body deep black.

Hair of head and thorax white, abundant; bands of abdomen conspicuously broader, 1st

narrower, 1st tergite on both sides with a patch of fine whitish tomentum; the tomentum of the bands finer; all bands whitish, in fresh examples with a brownish tint; hair of the legs yellowish grey.

Scutellum densely punctate all over.

Clypeus and supraclypeal area rather densely punctate.

Vertex, seen in profile, conspicuously ascending behind the hind ocelli, so that it forms together with the outline of the occiput an angle somewhat less than 90°.

tergite on the disk in front with a tomentose transverse band, narrow or interrupted in the middle, the tomentum of the bands thicker; all bands chalky white; hair of the legs white, only on the inside of the hind basitarsi yellowish.

Scutellum as a rule on both sides with a sparsely punctate polished area.

Clypeus and supraclypeal area as a rule partly with scattered punctation.

Vertex, seen in profile, hardly ascending behind the posterior ocelli, so that it forms together with the outline of the occiput an angle somewhat more than 90°.

Holo- and allotype (both Beersheba, 23.VI) coll. m. Paratypes: Jerusalem (Mt. Scopus), 1 ♀, V (Tenenbaum leg.); Jaffa, 6.V; Bat Yam, many ♂♂♀♀, 24.III—19.V (ByS); Beersheba, 2 ♂♂, 2 ♀♀, 13—23.VI (ByS); Gvulot, ♀, 30.V (ByS), 1 ♀, 18.V (Verhoeff leg.); Revivim, 4 ♀♀, 16.V—15.VI (ByS, Verhoeff leg.).

1 ♀ Urim, 15.V (ByS), 1 ♀, Bnei Braq (ByS), not designed as paratypes owing to their worn condition.

**Halictus tibialis* Walk., 1871

List Hym. Egypt, p. 42, n. 205, ♂. Loc. typ.: Wadi Ferran (Sinai). — 1871, *Halictus distinctus* Walker, ibid., p. 42, n. 204, ♀ (nom. preocc.). Loc. typ.: Wadi Genneh (Arab. Desert). — 1926, *Halictus dampfi* I. D. Alfken, Bull. Soc. R. Ent. Egypte (1927), p. 103, n. 11, ♀ ("dampti" misprinted). Loc. typ.: Meadi (near Cairo).

Nahal Zin (Wadi Fukra, Negev), 1 ♀, IV.45 (leg. coll. ByS). Hitherto known only from Egypt (see above; Djebel Elba [Wadi Aideb)] and Sinai.

The ♀ is very near to *subsenilis* ♀, but can be easily distinguished by the peculiar granular structure of the median segment and by the narrow POL (POL : OOL : OVL = 13 : 19 : 13); moreover, the face is conspicuously broader and less convergent below.

**Halictus fatsensis* Bluethg., 1936 (♀, new description)

1936, Mitt. Zool. Mus. Berlin, p. 276, ♂. Loc. typ.: Fatsa (Mesopotamia).

Jerusalem (Mt. Scopus), 1 ♂, 14.VI, on *Ballota undulata* (W.); 1 ♂ (worn), 2.VII, 1 ♂ (rather worn), 12.V; Khan Khadrur, 1 ♂, 23.V (ByS).

The ♀ rather resembles the ♀♀ of several allied species, particularly those of *fulvipes* (Klug, 1817), *cochleareitarsis* Drs., 1872, *humkalensis* Bluethg., 1936, and *subsenilis* Bluethg., 1954, in the colouring of both body (dark greyish brown) and hair (incl. tergite bands). It may be distinguished at once from both *fulvipes* and *cochleareitarsis* (and also from *holtzi* [Schulz, 1906]) by the appearance of the hind slope of the median segment, which is in the latter totally plain including the upper lateral corners, with its lateral limitations edged up to above or nearly so, and with its whole surface entirely dulled by rough sculpture, while in *fatsensis* it is concave in the centre and rounded off laterally in the upper half, with its surface weakly shagreened, distinctly shiny and beset with scattered rasplike strong punctation, clearly contrasting with the surface. From both *subsenilis* ♀ and *humkalensis* ♀ (the ♀ of *luganicus* Bluethg., 1936, is not yet known) it differs as follows:

fatsensis ♀	*subsenilis* ♀ and *humkalensis* ♀
Lateral areas of the horizontal part of the median segment somewhat glistening, with the points much less fine than in *subsenilis* etc., deep and less dense (intervals on an average as broad as the points), only distally finer and denser.	Lateral areas dull, finely and very closely punctate.
1st tergite with the apical depression strongly separated from the disk, forming in front in the middle an obtuse angle, and with the disk distally rather stuffed, and before the stuffed part with a slight transversal impression.	1st tergite with its disk regularly convex, hardly swollen along the apical depression, the latter much less impressed and in front not angled but regularly convex.
Apical depression of the 2nd tergite rather strongly separated from the disk.	Apical depression of the 2nd tergite hardly separated from the disk.
POL : OOL : OVL = 17 : 19 : 11.	*subsenilis:* POL : OOL : OVL = 14 : 13 : 9; *humkalensis:* 11 : 16 : 12.

Form less oblong than in the cited allied species, rather stout, abdomen broad oval; face as long as broad (96 : 97), roundish, vertex elevated (= 18 from the level of the upper ends of the eyes to its ridge). Median segment seen from above as long as the postscutellum, semilunar. Apical part of the tergites strongly depressed (see above), bases of both 2nd and 3rd tergites distinctly impressed, with the disks swollen behind the basal impressions. Sculpture compared to that of a ♀ of *holtzi* of the same proportions. Punctation of the supraclypeal area rather fine, dense, that of the clypeus moderately dense, strong (about as in *holtzi*), clypeus shagreened, dullish. Punctation of the mesonotum conspicuously stronger, intervals on the average as large as the points; that of the scutellum similar, but a little finer than in the mesonotum; intervals on both mesonotum and scutellum smooth and shining. Median area of the median segment with very fine, extremely dense anastomosing wrinkles.

1st tergite with the punctation of the disk a little stronger and deeper than in *holtzi*, especially on the stuffed distal part, about as dense as in *holtzi*, the intervals distinctly shagreened, with feeble and silky lustre; sculpture of both base above and curved transition between base and disk as in the disk (strongly shiny, feebly shagreened, with scattered very weak punctation in *holtzi*). Sculpture of the 2nd tergite as that of the 1st tergite, the points hardly finer but still more crowded.

Apical depressions of the tergites ferruginous to a greater or smaller extent. Wings yellowish, apically feebly clouded, veins and stigma amber. Small joints of the tarsi testaceous. Hair as in the allied species, yellowish grey, whitish on temples and on sides of the thorax (incl. median segment); 1st tergite in fresh specimens with a patch of whitish decumbent pubescence in front on both sides; apical bands of tergites moderately broad, that of the fore 2 tergites not filling up the depression in the middle; 2nd tergite with a narrow basal band besides; all bands whitish, with a slight yellowish grey tint in fresh specimens. Length: 9.5—10.5 mm.

Allotype: 1 ♀, Jerusalem, 5.III.40 (leg. coll. ByS). Paratypes: 1 ♀, Jericho, 20 — 28.IV.27 (E.), c.m.; 1 ♀, 'Ein Fara, 4.XII (Mus. Stuttgart); 1 ♀, Qiryat 'Anavim, 28.III.30 (Am.), c.m.; 1 ♀, Ras Zuweira (Negev), 29.III.46 (W.), c.m. 1 ♀ from Akrounda (Cyprus), 25.IV.31 (Mavromoustakis leg.), c. m., has the punctation of the 1st tergite conspicuously stronger than in the Israeli specimens and the intervals nearly smooth; it has not been designated as paratype.

Since in the types of the ♂ the hair is in bad condition, I am redescribing here the hair of fresh specimens: on the face, above up to the ocelli and the upper end of the eyes, extremely dense, diverging from the antennal pits round about and covering entirely the sculpture; on the clypeus tomentose; on the vertex erect, very dense; on the temples seen in profile behind as dense and long as on the vertex, erect, becoming gradually shorter in front so that it is tiny on the anterior half of the temples; on the thorax above in front, on the postscutellum and on the mesosternum nearly as long as on the vertex, on the thorax as for the rest somewhat shorter, very dense all over and largely covering the surface; median area of the median segment bare; 1st to 5th tergites with whitish bands covering the apical depressions, 2nd and 3rd with loose basal bands besides, 1st tergite on the base and on the curved part between base and disk with long dense erect hair as on the vertex, basal depressions of the 2nd and 3rd tergites with short erect hair (besides the basal bands); apical part of 6th tergite with fine brown pubescence; all hair whitish, partly greyish, and finely plumose. The hair on the temples is much longer than in *senilis* (Eversm., 1852) ♂ but much shorter than in *humkalensis* Bluethg., 1936, ♂.

Distribution: Mesopotamia and Israel; Cyprus (Akrounda).

**Halictus subalfkenellus* Bluethg., 1936

1936, Mitt. Zool. Mus. Berlin, p. 284, ♀. Loc. typ.: Taurus. ♂ unknown.

Tiberias, 1 ♀, 8.V (ByS); hair in bad condition, but for the rest totally agreeing with the paratype c. m.

Distribution: Asia Minor and Palestine; further localities unknown to me.

Halictus cedens Bluethg., 1931

1924, *Halictus posthumus* Bluethg., Arch. Naturg., **90** (1925), **A. 10**, p. 93, ♂ (nom. preocc.). — 1931, *Halictus cedens* nom. nov. Bluethg., Mitt. Zool. Mus. Berlin, **17**, p. 321. Loc. typ.: Murut (Caucasus). ♀ unknown.

Distribution: further localities are: Taurus (1 ♂, 7.VIII, M.P.), Beirut (1 ♂, c.m.) and Zahle (Lebanon) (1 ♂, c.m.).

Halictus quadricinctoides Bluethg., 1936

1936, Mitt. Zool. Mus. Berlin, **21**, p. 282, ♀. Loc. typ.: Taurus. ♂ unknown.

Distribution: Asia Minor (Taurus); not found elsewhere hitherto.

maculatus group

**Halictus asperulus* Pér., 1895

1895, *Halictus rugosulus* Pér., Espèces nouv. de Mellifères, Bordeaux, p. 52 (nom. preocc.). *Halictus asperulus* Pér. nom. nov., ibid. Loc. typ.: not recorded.

Jericho, 4 ♀♀, 17.IV.99 (M.), 1 ♀, 20—28.IV.27 (E.); Wadi el Kelt, 1 ♀ (E.); Jerusalem, 2 ♂♂, 15—30.V (ByS); Deganya, 1 ♂, 20.VI (ByS); Tiberias, 3 ♀♀, 21.III—16.V (ByS); Daphne Oaks, 2 ♀♀, 13.V (fr. sp.); Nir 'Am, 1 ♂, 10.VI (ByS).

Distribution: Spain, south France, Italy, Dalmatia, Herzegovina, Serbia, Romania, Greece (including islands), Crimea, Transcaucasia, Asia Minor (incl. Rhodes and Cyprus), Syria to south-west Persia.

Halictus maculatus Sm., 1848

1848, Zoologist, **6**, p. 2172, ♀.

Distribution: Europe; Asia Minor: Polish Tshifflik on Bosporus, Adana, Ankara, Kuetahye (1 ♂, ByS).

tetrazonius group

**Halictus aegypticola* Strand, 1909

1909, Arch. Naturg., **75**, p. 21, ♂ (nec ♀ = *senilis* [Eversm., 1852] ♀). Loc. typ.: "Egypt". — 1913, *Halictus libanensis* Pérez, Bull. Soc. Am. Sci. Natur. Rouen, **47**, p. 84, ♀. Loc. typ.: Beit Meri (Lebanon).

Jerusalem, 1 ♀ (M.P.), ♂♀♀ (fr. sp.), 21.VII — 11.IX (ByS); Qiryat 'Anavim, 1 ♂, 10.X.30, 1 ♀ (Bo.); Nablus, 1 ♀, 19—26.IV.34 (E.), c.m.

Distribution: hitherto known only from Egypt (if the type locality [Ehrenberg leg.] is correct), Palestine and Syria. The type of the ♀ (M.P.) is dated "12.6.08".

Halictus patellatus Mor., 1873

1873, Horae soc. ent. Ross., **10**, p. 162, ♂. Loc. typ.: Derbent.

Distribution: from Turkmenistan, northern Persia (Tabris), Trans- and Cis-caucasia, Armenia, Asia Minor, Volga district, Crimea, Turkey, Romania, Bulgaria, Greece (including Crete), Dalmatia, Carinia, Hungary, Slovakia, south-east Bohemia, east Austria, Italy, south-west France to north Spain. Found in Asia Minor near Kawak (M.B.) and near Kuetahya (1 ♂, 14.VIII.51, ByS). In coll. Friese (M.B.) specimens from "Syria".

**Halictus* sp. aff. *tetrazonius* (Klug, 1817) ♀

Natanya, 1 ♀, 12.VI.46 (W.).

**Halictus* sp. aff. *tetrazonius* (Klug, 1817) ♀

Jericho, 1 ♀, 20—28.IV.27 (E.)

Most of the ♀♀ belonging to this abundant group are so similar to each other that the minute differences are not to be expressed either by words or by drawings.

Halictus* **galileus n. sp. ♂

This ♂ belongs to the *simplex* division (base of mandibles not dilated beneath). It differs from the ♂♂ of *simplex* Bluethg., 1923, *furcatus* Bluethg., 1925, and *ponticus* Bluethg., 1936, by the light and conspicuously less long antennae and by the stouter build; from *tetrazonianellus* Strand, 1909, ♂, which it rather resembles in the two previous characteristics, by the black colour of labrum and mandibles, by the somewhat longer and above partly darkened flagella, by the edged lower part of temples which — seen in profile — are distinctly curved (straight in *tetrazonianellus*), by the lower edge of fore femora being hairy (glabrous in *tetrazonianellus*), by the less fine punctation of the tergites, and by the less enlarged femora.

Flagellum, except 1st joint, testaceous, above, except for the two least joints, blackish, largely on the proximal joints, in lesser extension gradually on the following ones, forming narrow longitudinal streaks, linear on 7th to 10th joints; all joints of flagellum without basal or distal ringlets, moderately and waxy shining, 4th to 11th joints swollen

beneath, the convexities gradually stronger; length of 3rd joint = 18 : 9.25, of 4th = 16 : 10. 1st to 5th tergites each with a narrow white apical hair band, the 1st narrowed in the middle.

Face = 114 : 105; POL : OOL : OVL = 17 : 19 : 17. Pectinate appendix of the stipites furnished with a hair pencil. For the rest, as usual in this group. 12 mm.

Qiryat Shmona (Upper Galilee), 3 ♂♂, 21.VI—7.VII (BySS). Holotype coll. m. Paratypes coll. BySS. 1 ♂ from Umago (Istria) and 1 ♂ from Simontornya (Hungary), both coll. m., appear to be conspecific.

**Halictus tetrazonianellus* Strand, 1909

1909, Arch. Naturg., **75**, p. 58, ♀. Loc. typ.: Volissos (Chios), Samos, Rhodes. — 1921, *Halictus leucognathus* Morice, J. Bombay Natur. Hist. Soc., p. 80, ♂. Loc. typ.: Baquba (Mesopotamia). — 1921, *Halictus apatellatus* Strand, Arch. Naturg., **87**, p. 309, ♂. Loc. typ.: Asia Minor.

Jerusalem, ♂♂ ♀♀, 10.VI—28.VIII (Bo., BySS); Ma'ale Hahamisha, 1 ♀, 11.VI (worn) (BySS); Ramat Gan, 1 ♂, 9.V (BySS); Beeri, 1 ♀, 1.VI (BySS); Haifa, ♂♀, 8.IV—12.VII (fr. sp.) (BySS); Nahariya, 1 ♀, 6—8.V (V.); Rosh Haniqra (Ras el Nakura), 1 ♀, 9.VII (BySS); Eilon, 1 ♂, 15.VIII (BySS); Sejera, 2 ♂♂, 11.VII (BySS); Rosh Pina, 3 ♂♂, 3.VII (BySS); Dan, 1 ♀, 11.V (worn) (BySS).

Distribution: from Transcaspia (Kopet Dagh near Askhabad) and Mesopotamia through north Persia (Mugan steppe), Transcaucasia (Helenendorf, Elisabethpol, Kasikoporan, Derbent, Araxes valley), Ciscaucasia (Gulkevitshi) to the Ukraine (Voroshilovsk near Lugansk, Krasnograd near Poltawa), Armenia, Asia Minor (including Cyprus, Rhodes and other islands), Turkey (Chal-Kali near Istanbul), Greece (including Corfu, Crete, Euboea etc.), Syria (Beirut, Tartous). Not recorded hitherto from Egypt.

subauratus group

**Halictus subauratus* (Rossi, 1792)

1792, *Apis subaurata* Rossi, Mant. Jns., p. 144, ♀. Loc. typ.: Italy. — 1794, *Apis seladonia* Fabricius, Entom. Syst., IV, p. 460, ♀. Loc. typ.: Italy. — 1841, *Halictus virescens* Lepeletier, Hist. natur Jns. Hymén., II, p. 279, ♀. Loc. typ.: near Paris. — 1849, *Halictus gramineus* Smith, Zoologist, VII, App. p. lviii, ♂♀. Loc. typ.: Cove Commons, Hants. — 1873, *Halictus meridionalis* Morawitz, Horae soc. ent. Rossiae, **10**, p. 170, ♂♀. Loc. typ.: Derbent.

Jerusalem, 9 ♀♀, 3 ♂♂, 1.VI—29.X (BySS); Qiryat Shmona (Upper Galilee), 1 ♀, 21.VI (BySS).

Distribution: from Spain to south Siberia (Barnaul), Turkestan, Kashmir, Baluchistan (Quetta). This species is absent in the north of Central Europe and also in North Africa, except for Morocco.

**Halictus smaragdulus* Vach., 1895, ssp.

1895, *Halictus smaragdulus* Vachal, An. Soc. Espan. Hist. Natur., (2) **4**, p. 150, ♂. Loc. typ.: Seville. — 1903, *Halictus barcelonicus* Pérez, Espèces nouv. Mellifères, Bordeaux, p. 44, ♀. Loc. typ.: Barcelona.

Jericho, ♀, 2.X; Jerusalem, 6 ♀♀, 2 ♂♂, 4.VI—28.IX (Bo., BySS); Urim, ♀, 15.V; Haifa (Carmel), ♀, 12.VI (BySS).

This species forms numerous subspecies and it needs a revision, which I have not yet been able to do myself.

Distribution: from Spain to the Kopet Dagh, occurs also in North Africa and even in the south of Central Europe.

Halictus geminatus Pérez, 1903

1903, Espèc. nouv. Mellifères, Bordeaux, p. 42, ♂♀. Loc. typ.: west and south France. Asia Minor (Adana, Makri [Taurus]).

Distribution: from Spain to the Tienshan and east Bukhara; not known for certain from North Africa, sparsely in the south of Central Europe, absent in Germany.

**Halictus cephalicus* Morawitz, 1873

1873, Horae soc. ent. Ross., **10**, p. 173, ♀. Loc. typ.: Derbent, Baku. — 1920, *Halictus conjugens* Bluethg., Dtsch. Ent. Z., p. 299, ♀; 1923, Arch. Naturg., **89, A.5**, p. 235, ♂. Loc. typ.: Attika (♀), Helenendorf and Erdschias (♂). — *Halictus neuter* Bluethg., Arch. Naturg., l. c., p. 235, ♀. Loc. typ.: Helenendorf.

Jerusalem, ♀, 7.VII, on *Thymus*, 1 ♂, 12.X, on *Inula viscosa* (W.); Dir Yassin, 1 ♀, 7.VIII (ByS), 1 ♂ (stylopized), 5.X.30 (Bo.); Qiryat 'Anavim, 2 ♀♀, 1.IX.30, 26.X.30 (Bo.); Nablus, 1 ♀ (E.); Eilon, 15.VIII (ByS).

Distribution: from Daghestan (Derbent), Azerbaidjan (Baku), Transcaucasia (Elisabethpol, Helenendorf, Borshom, Kasikoporan, Araxes valley), Armenia (Eriwan) to Syria (Latakia, Beirut), Israel and Mesopotamia (Taitis), and through Asia Minor (Adana, Taurus, Ankara, Samsun, Polish Tshiftlik on the Bosporus, Cyprus, Rhodes), Turkey (Istanbul) to Macedonia (Ueskueb, Doiran, Bogdanci).

Halictus verticalis Bluethg., 1931

1931, Mitt. Zool. Mus. Berlin, **17**, p. 396, ♀. Loc. typ.: Taurus. ♂ unknown.

Asia Minor: Taurus, Guelek, Akshehir, Adana, Dinar (1 ♀, 9.VIII.51, ByS), Eregli (1 ♀, 11.VII.52, Seidenstuecker leg., coll. E.). Other localities not known to me.

**Halictus varipes* Morawitz, 1876

1876, in Fedtschenko, Turkestan Mellifera, II, p. 223, ♂♀. Loc. typ.: Dshisak. — 1895, *Halictus dives* Pérez, Esp. nouv. Mellifères Barbarie, Bordeaux, p. 51, ♀. Loc. typ.: not quoted by the author (the type specimen is labelled "Biskra"). — 1907, *Halictus omanicus* Pérez, Bull. Sci. France & Belg., (6) **1**, p. 489, ♀. Loc. typ.: Muscat.

The type series (coll. Fedtschenko, M.M.) which I have examined is composed of examples of 3 species, viz. *varipes*, *smaragdulus* ssp., and *annulipes* Mor., 1876. I hereby designate as holotype 1 ♀ from Dshisak (19.VII), as paratype 1 ♀ from Katti-Kurgan (29.IV) and as allotypoids 2 ♂♂ from Dshisak (14.VII, 19.VII). Only these 4 specimens belong to the species *varipes*.

Jericho ('Ein Sultan), 1 ♂, 19.IX, on *Pluchea dioscoridis* (W.); Jerusalem, 3 ♀♀, 31.V.31, 15.VI.31, 1.IX.31 (Bo.); Nablus (E.).

Distribution: occurs from the Gobi desert (oasis Satshzhou), through Turkestan, Gudjarat (Deesa), Baluchistan (Quetta, Jao), Iraq (Basra), Mesopotamia (Amara), to both Arabia (Muscat, Aden) and Israel. The subspecies *dives* Pér., 1895, inhabits North Africa from south Algeria (Biskra), Tunisia (Tozeur, Gabes), Cyrenaica (Giarabub) and Egypt (around Cairo, Assouan) to Nubia (Atbara) and Kordofan (Sennar).

Halictus gemmeus Dours, 1872

1872, Rev. & Mag. Zool., **23**, p. 310, ♂♀. Loc. typ.: Algeria and south France.

Homs (Syria), 1 ♀, 13.V.52 (Seidenstuecker leg., coll. E.); "Syria" (coll. Friese); Asia Minor: Polish Tshiftlik on the Bosporus, 3 ♀♀ (F.).

Distribution: mainly confined to the Western Mediterranean zone (southern Europe, North Africa). I know of a single specimen only from Egypt, ♀ labelled "Cairo", that I received from the commercial house Dr. O. Staundinger, Dresden, but I doubt whether the locality is correct. Neither have I seen specimens from Cyrenaica so far.

tumulorum group

Halictus tumulorum (Linnaeus, 1758)

1758, *Apis tumulorum* Linnaeus, Syst. nat., Ed. X, I, p. 574, ♂. Loc. typ.: Sweden. — 1787, *Apis flavipes* Fabricius, Mant. Insect., I, p. 305, ♂. Loc. typ.: Kiel.

Recorded by Bodenheimer. I feel doubtful, however, whether the identification is correct, particularly since I have hitherto seen only a single specimen of this species from Asia Minor (Sultan Dagh near Akshehir, 1600 m, 1 ♂, VIII.34, M.Mu.).

Distribution: a Eurosiberian species, inhabiting in southern Europe the mountains only, and not found in North Africa.

vestitus group

Halictus* **semiticus n. sp. ♂♀

This species belongs to the *vestitus* group, differing from the other green species of this group thus:

♂: To be distinguished at a glance from all other ♂♂ by the peculiar shape of both the 5th and 6th sternites and by the form of the processus of the 4th sternite: the 5th sternite has a broad and rather deep, distally widening, longitudinal, median furrow, while in the other ♂♂ it is totally flat; the 6th sternite has in the middle a transverse swelling, not interrupted in the middle, and in front of it a large roundish deep pit (the apex of the sternite impressed as usual); the processus of the 4th sternite is tiny, only as long as broad, and arises immediately before the apical edge of the sternite, so that it may be easily overlooked.

Face distinctly longer than broad (55 : 50), clypeus protruding; antennae slender, 3rd joint of flagellum = 9 : 6.75; 4th = 10 : 7. Apex of clypeus narrowly, middle of mandibles, labrum, tips of femora, tibiae and tarsi pale yellow, the mid and hind tibiae richly stained with black, claw joints of the tarsi testaceous; flagellum dark brown beneath, the 2nd joint partly orange.

Head and thorax hairy and partly tomentose, as usual in the ♂♂ of this group; tergites on their deeply depressed apical part with broad, dense, whitish hair bands, 1st to 3rd moreover thickly tomentose basally and laterally, so that the chitinous surface can be seen only as a narrow band on the distal half of the disks; it is about as broad as the apical bands, curved in front, does not reach the sides, and is hidden by a microscopic yellowish pubescence; disks of the following tergites rather densely beset with thick, white hair; 2nd to 5th sternites not tomentose (only in quite fresh specimens white tomentose bands on the ends of the 2nd and 3rd sternites).

Punctation about as in *vestitus* Lep., 1841.

♀ : Bronze green, clypeus dark chestnut, basally with purplish reflexes, its

translucent end reddish, supraclypeal area bright metallic green, antennae dark brown, flagellum reddish brown beneath. Abdomen pale red, the last tergites darkened, the 1st (in some specimens also the following) with green lustre. Mandibles partly and humeral calli yellow; legs chestnut, tips of femora, tibiae and tarsi testaceous, middle and hind tibiae largely chestnut, bases of fore and middle tibiae with a small ivory spot. Wings hyaline, nervures and stigma very pale amber.

Tergites hidden by thin, delicate, whitish (in quite fresh specimens probably yellowish) tomentum, covering on the anterior 3 tergites only the base, the sides, and the apical part, so that there remain on the apical half of the disks transverse streaks that are covered only with transparent microscopic yellowish pilosity and that show the surface of the chitin (as in the ♂). Hair as for the rest as in *vestitus* Lep., 1841, ♀, on the front, vertex (seen from in front), mesonotum and scutellum nowhere tomentose.

Head rather big, only slightly converging behind the eyes, temples, seen in profile, somewhat broader than the eyes; face = 79 : 81, almost circular, vertex nearly semicircular, POL : OOL : OVL = 14 : 16 : 5.

Sculpture as in *vestitus* ♀, except that the punctation is somewhat finer (taking into account the difference in size of the two species) and less dense (only a little on the mesonotum and the lateral areas of the median segment, more conspicuously on the clypeus).

Length: 5—5.5 mm.

Jericho, 1 ♀, 19.VI.43, 1 ♂, 26.VIII.45 (ByS); Jerusalem, 4 ♂♂, 6 ♀♀, 18.VI—17.X.30 (Bo.), 2 ♀♀, "on *Thymus*", 7.VII.40, "on *Echium*", 15.VIII.45 (W.), 2 ♂♂, 20.VI.43, 6.VIII.39 (ByS). Holotype (♂, 17.X.30) and allotype (♀, 18.VI.30), both from Jerusalem, in M.B., paratypes (the other specimens) in M.B. (Bo. leg.), coll. ByS, coll. Wahrman and coll. m.

**Halictus* aff. *vestitus* Lep., 1841

There are at least 3 different species of the *vestitus* group that occur in Israel. It would serve no purpose to enumerate them here, since this group, one of the most complex in the genus *Halictus*, badly needs a revision.

mucoreus group

**Halictus pollinosus* Sichel, 1860

1860, Ann. soc. entom. France, (3) **8**, p. 763, ♀. Loc. typ.: Sicily.—1876, *Halictus cariniventris* Morawitz, in Fedtschenko, Turkestan Mellifera, II, p. 226, ♂. Loc. typ.: Osch, 1.VIII.71, cotype in M. M., designated hereby as lectoholotype.

Jerusalem, 1 ♂, 15.VII; 15 km E. of Gaza, ♀, 10.VI; Beer Tuvia, 1 ♂, 3.VI (fr. sp.); Deganya, 1 ♂, 20.VI (all ByS).

Distribution: from both Turkestan and Baluchistan (Quetta, Peshin) to Spain. The question whether the Halicti that represent this group in North Africa belong to *pollinosus* or to *thevestensis* Pérez, 1903, requires investigation.

**Halictus tuberculatus* Bluethg., 1925 ♀ (New description)

1924, Arch. Naturg., **90** (1925), **A. 10**, p. 125, ♂. Loc. typ.: Araxes valley.

Jericho, 1 ♀, 25.III (worn), 1 ♀, 3.IV (rather fr. sp.), 1 ♀, 9.IV (worn) (ByS) 1 ♂, 2 ♀♀ (fr. sp.), 19—26.IV (E.); Jerusalem, 1 ♂, 15.VII, 1 ♀, 19.IX (worn) (ByS), Mt. Scopus, 1 ♀, 29.IX, on *Varthemia iphionoides* (W.); Qiryat 'Anavim, 1 ♀, 1.IX (Am.); Tiberias, 1 ♀, 16.V (nearly fr. sp.) (ByS); Rosh Pina, 2 ♂♂, 3.VII (worn) (ByS); Beersheba, ♀, 23.IV (ByS).

Distribution: the Ukraine (Voroshilovsk near Lugansk), Tauria (Otuzy), Ciscaucasia (Petrovskoye near Stavropol, Gulkevitshi), Transcaucasia (Araxes valley), Syria (Ksara), Israel.

The hitherto not described ♀ of this species is hardly to be distinguished from *pollinosus* ♀, as is generally the case in the ♀♀ of the *mucoreus* group: it is somewhat smaller in size, its vertex is somewhat less elevated, the punctation on the clypeus is denser, that on both front and supraclypeal area a little finer.

Neallotype: 1 ♀ from Jericho, 19—26.IV.34 (Enslin leg.), c.m. Neoparatypes: the ♀♀ mentioned above.

radoszkovskii group

**Halictus* aff. *radoszkovskii* Vachal, 1902

1902, *Halictus radoszkovskii* Vachal, Rev. Russe d'Entom., **2**, p. 228, ♀ (nec ♂ = *Halictus nasica* Mor., 1876, ♂). Loc. typ.: Askhabad.

Khan Khadrur, 1 ♂, 23.V (ByS); Binyamina, 1 ♀, 27.VI (ByS). The description will be given in a paper on this interesting group which I have in preparation.

Subgenus **Thrincohalictus** n. subg.

(Subgenotype: *Halictus prognathus* Pérez, 1912)

Halictus* (Thrincohalictus**) *prognathus* Pérez, 1912 (♂ described here). Figure 4a, b.

1912, *Halictus prognathus* Pérez, Bull. Soc. Am. Sci. Natur. Rouen, 46, ♀. Loc. typ.: Baalbek (Lebanon). — 1923, *Halictus carduelis* Bluethg., Arch. Naturg., **89, A. 5**, p. 287, ♀. Loc. typ.: Amanus Mts.

This species has hair bands on the apices of the tergites, but these differ structurally from the normal type and, moreover, cover only the middle of the apical depressions in front; in the ♀ the shape of the elongated head is quite different from the usual (face = 92 : 84; width of occiput = 83, width of mesonotum = 78; width of temples: width of eyes, both seen in profile = 25 : 22; length of clypeus = 21, width of its end = 27), and the inner spur of the hind tibiae has 4—5 long spines, the 2nd and the following being stout, parallel-sided, with blunt tip, the 2nd about 2.5 times as long as the width of the spur, the following gradually shorter, the 1st sometimes shorter than the

2nd, thin, acute, — while in the true *Halictus* (including *Seladonia*) ♀♀ the spur shows only a row of numerous minute nodosities or small acute teeth.

The hitherto unknown ♂ that Bytinski-Salz has succeeded in capturing shows by some peculiarities a surprising affinity with the genus *Thrinchostoma* Sss., viz. by the shape of the head and by the structure of the sternites.

♂: Black, clypeus distally and labrum white, flagellum testaceous beneath, more darkened distally, tips of femora, tibiae and tarsi whitish yellow, tibiae stained with chestnut, claw joints of tarsi testaceous; apical depressions of the tergites testaceous. Hair generally as in the ♀, face laterally thickly covered with whitish hair, clypeus sparsely bristled; 2nd and 3rd tergites (as far as one can say, considering the bad condition of the hair bands) banded not only on the ends but also basally and laterally. Sculpture as in the ♀, the punctation on the mesonotum somewhat, on the tergites conspicuously, denser. Face = 106 : 79, clypeus greatly protruding, conspicuously longer than the width of its end (28 : 25), cheeks very elongated, seen in profile nearly twice as long as the width of the base of the mandibles, seen in front as long as the width of the end of the clypeus; both supraclypeal area and clypeus in profile strongly protruding; underside of head longitudinally grooved on both sides of the median furrow; mandibles simple; antennae slender, moderately long, 3rd joint of flagellum = 12 : 8; 4th = 12.5 : 8, joints of flagellum slightly swollen beneath, last joint shaped as usual; ocelli rather large, POL : OOL : OVL = 15 : 10.5 : 9.

Abdomen subelliptical, apices of the tergites and bases of both 2nd and 3rd tergites depressed, disks of the latter swollen behind the basal depression; 4th sternite covered by the 3rd, except laterally, its concave posterior edge furnished with a broad, dense pecten of fish-bone-like, erect, distally slightly curved bristles, becoming gradually narrower towards the middle of the sternite (exterior bristles = 13, inner = 7); 5th sternite with the end semicircularly emarginate and with its disk furnished with 2 curved blunt ridges arising from its base in the middle and diverging behind, delimiting laterally the apical depression in front; also with a slight longitudinal medio-distal furrow, the 2 ridges fringed inside with depressed long ciliae which become shorter laterally; the end of the sternite shortly fringed. 6th sternite on the base with a dense, broad brush of long, decumbent, pale hair, diverging obliquely from the middle, so that a rectangular gap remains in the middle; disk of the 6th sternite slightly excavated, beyond the middle with transverse lateral swellings, densely covered with depressed hair; all hair of the sternites pale golden. Legs, including femora beneath and tibiae inside, very hairy.

Fore tarsi slender, 2nd joint about 2.5 times as long as it is broad. Length: 9 mm.

The morphological peculiarities of both sexes justify the establishment of a separate subgenus.

Distribution: Allotype near Sejera, 11.VII.45 (ByS), c.m.; I have seen ♀♀ from Kinneret, 30.III.37 (P.), Baalbek (holotype), Amanus Mts. (typus *carduelis*), Eriwan, 1 ♀ (M.Mu.) and Chios, 3 ♀♀, 8.V.39 (E. leg., coll. E. and m.).

LIST OF ABBREVIATIONS

A — Alfken
Am — Amsel
Bo — Bodenheimer
ByS — Bytinski-Salz
E — Enslin
M — Morice
P — Palmoni
V — Verhoeff
W — Wahrman

M.B. — Zoolog. Museum of the Humboldt University, Berlin
M.Mu. — Zoolog. Staatssammlung, Munich
M.P. — Mus. Nat. d'Hist. Naturelle, Paris
M.V. — Naturhistor. Staatsmuseum, Vienna
fr. sp. — fresh specimen(s)
c. m. — collectio mea

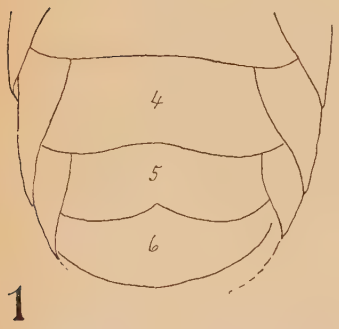
Note: Specimens from all recorded localities have been examined by me.

POL — distance between hind ocelli;

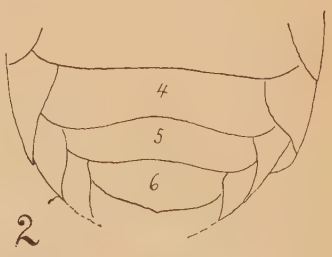
OOL — smallest distance between hind ocellus and upper end of eye;

OVL — Vertical distance between hind ocellus and ridge of vertex;

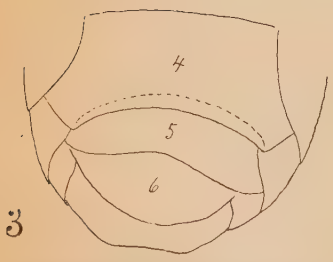
Face — length from vertex to end of clypeus: width incl. eyes.



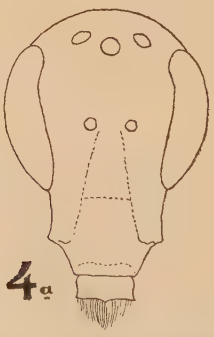
Halictus luganicus Bluethg. ♂, 4th—6th sternites



Halictus subsenilis n. sp. ♂, 4th—6th sternites



Halictus humkalensis Bluethg. ♂, 4th—6th sternites



Halictus (*Thrincohalictus*) *prognathus* (Pér.) ♂, face

Halictus (*Thrincohalictus*) *prognathus* (Pér.) ♂, head in profile

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NEW DIPLOPTERA FROM ISRAEL AND THE NEAR EAST. I.

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ABSTRACT

Description of 11 new species and subspecies of Eumenidae; the type localities, if not mentioned otherwise, are Erez Israel.

Leptochilus mauretanicus (Lep.) **derufatus** ♀; *L. limbiferus* (Moraw.) **anatolicus** ♀ (Turkey); *L. membranaceus* (Moraw.) **luxuriosus** ♀; *L.* **bellus** ♀; *L.* **kurnubensis** ♂♀; *Microdynerus* **latro** ♀; *Parodontodynerus ephippium* (Klug) **aramaeus** ♀; *Euodynerus posticus* (H. Sch.) ssp. *punctatissimus* G. S. v. **nahariensis** ♂♀; *Deuterepipona herzi* (Moraw.) **enslini** ♀; *Pterocheilus albidus* G. S. **aramaeus** ♂♀; *P.* **paravespoides** ♂♀.

New synonym: *Pterocheilus albidus albidus* G.S. 1943 ♂ (= *P. sempti* G. S. 1943 ♀).

In this first in a series of papers are given the descriptions of 11 new species and subspecies of Eumenidae chiefly from Israel. An annotated list of the Diploptera of the entire Near East will follow later.

Genus *Leptochilus* Saussure, 1852
(Type: *L. mauritanicus* [Lep., 1841], Desig. by Ashmead, 1902)
Subgenus *Leptochilus* Sss., 1852

Lept. (*Lept.*) *mauritanicus* **derufatus** n. ssp. ♀

The type specimen differs from *m. mauritanicus* ♀ as follows: emargination of the clypeus less broad (in proportion to the distance between the antennal pits — 20 : 22, in *m.m.* — 24 : 24), punctation of 1st tergite somewhat finer and denser and more superficial; both 1st tergite and 1st sternite black without any trace of red pigment; clypeus black, with only some tiny irregular whitish spots in the middle; 3rd tergite distally with a white patch; basal half of the femora black. For the rest as in *m.m.* ♀.

Holotype: 1 ♀, Kfar Yeroham (Negev), 20.IV (Bytinski-Salz leg.), coll. m.

Subgenus: *Euleptochilus* Bluethgen in Berland 1943[1]
(Subgenotype: *Leptochilus oraniensis* [Lep., 1841]. Orig. desig.)

Lept. (*Eulept.*) *limbiferus* (F. Mor., 1867) **anatolicus** n. ssp. ♀

Differs from *l. limbiferus* ♀ by the colouring: designs of the body and tegulae ivory white, not yellow; 3rd to 5th tergites without bands, 2nd sternite with lateral patches only (in *l. l.* ♀ usually with an interrupted band); femora testaceous with their basal third brownish, those of the forelegs distally outside with a white streak; tibiae and tarsi testaceous; antennae totally black, scape at the most with a reddish spot at its end. The white marking on clypeus, pronotum, mesopleurae, and scutellum may be tinged by reddish at their margins. For the rest as in *l. l.* ♀.

Holotype: 1 ♀, Kawak (SW Samsun, Anatolia), 29.VI.1926 (H. Bischoff leg.), Zool. Mus. Berlin. Paratype: 1 ♀, Ankara, VI.1934 (A. Seitz leg.), Senckenberg-Museum, Frankfurt a/M.

Received April 20, 1955.

Subgenus *Lionotulus* Bluethgen, 1938
(Subgenotype: *Microdynerus alpestris* [Sauss., 1856]. Orig. desig.)

Lept. (*Lion.*) *membranaceus* (F. Mor., 1867) ssp. **luxuriosus** n. ssp. ♀

Differs from *m. membranaceus* ♀ thus: punctation of the body, especially on the tergites and 2nd sternite, much coarser and denser; markings of clypeus, pronotum, scutellum, and tergites much more developed, yellow, not whitish, postscutellum with a yellow spot behind; underside of the scape, and tops of femora and tibiae, light yellow (the latter testaceous in *m.m.* ♀).

Holotype: 1 ♀, Jerusalem, 12—14.V.1951 (P. M. F. Verhoeff leg.), coll. m.

Lept. (*Lion.*) **bellus** n. sp. ♀

Strikingly resembling *Leptochilus neutralis* (G. S., 1943) ssp. *rufior* G. S., 1952[2], ♀ (loc. typ.: Qiryat 'Anavim near Jerusalem), of which I was able to examine 2 specimens from Jerusalem (J. Wahrman leg., 25.V.46 on *Teucrium polium*, 5.VI.46 on *Echium*). The general aspect, especially the shape of the head and the 1st tergite, and the development of the pronotal carina, is the same in both species.

The main differences are as follows:

L. bellus ♀

Punctation of 1st tergite strong, dense, and deep, points on the average only as large as the smallest points of the mesonotum; that of 2nd tergite moderately dense, basally rather strong, but less than on the 1st tergite, and shallower, distally feeble and shallow; apical lamella of the 2nd tergite only with a row of very fine inconspicuous points at its base; 3rd tergite with rather scattered, feeble, and shallow punctation; punctation of 2nd sternite much finer, and in the middle largely scattered; that of the head also much finer and less dense; emargination of the clypeus very narrow and shallow.

Ground-colour of both clypeus and pronotum black; the white patches of the latter outwards not pointed; underside of the flagellum black; tegulae and parategulae orange, without white; legs ferruginous, middle and hind femora with the basal half auburn, femora and tibiae without white colouring.

L. neutralis rufior ♀

Punctation of 1st tergite coarse, very dense, deep, with its intervals raised; that of 2nd and 3rd tergite dense, coarse, and deep; lamella of the 2nd tergite with a row of strong, oblong, clear points reaching its end; punctation of 2nd sternite coarse and dense, even in the middle; head strongly and very closely punctate; emargination of the clypeus somewhat wider.

Ground-colour of both clypeus and pronotum red; the white patches on the latter outwards narrowed and pointed; underside of the flagellum ferruginous; tegulae in front and behind, and parategulae white; legs including coxae and trochanters red, femora without dark base, outside of the fore femora with a white patch, all tibiae with a white streak.

Holotype: 1 ♀, Jericho, 20—28.IV.1927 (leg. E. Enslin), coll. m.

In *Leptochilus n. neutralis* G.S., 1943, ♀ (loc. typ.: Amasia[3]), according to the description the colour of pronotum (partly), antennae and legs, and also the punctation of the lamella of the 2nd tergite is as in *n. rufior*, and the punctation of the 2nd tergite is less dense but even stronger than in *n. rufior*. Both species belong to the group of the Egyptian *Leptochilus flexilis* G. S., 1938[4].

Lept. (*Lion.*) **kurnubensis** n. sp. ♂♀

♂♀. Head and thorax black, with ivory white, thorax in the ♀ with orange markings, abdomen, except the brown last segment and the petiolus, orange with ivory white bands; face thickly covered with silvery hair.

♀. White are: clypeus (its end narrowly yellowish), a small spot behind the top

of the eyes; pronotum (behind with an orange patch), propleurae, tegulae (with 2 translucent spots and linear yellowish border), parategulae, mesepimerae, scutellum (in front with an obtuse-angled emargination), postscutellum, narrow bands on the ends of the 1st and 2nd tergites and 2nd sternite, the opaque lamellae of the 2nd tergite and 2nd sternite (except the translucent yellowish punctation), and incomplete distal bands on the 3rd and 4th tergites and 3rd sternite. Median segment totally orange. Mandibles red in the middle; scapes orange, below and in front ivory white, flagellum testaceous, above auburn; legs orange, femora outside distally with white patches, tibiae outside with white streaks, hind tarsi brownish above; wings greyish hyaline, veins and stigma brownish. Front, including sinus, covered with abundant, adherent, silvery pilosity, so that its sculpture is hidden; base and sides of the clypeus, upper half of the temples, mesopleurae, and lateral areas of the propodeum, all with similar, but finer, white pilosity, less dense on the mesopleurae; uppermost part of the front, vertex, and the thorax above, with abundant short, irregular, erect, whitish pilosity; abdomen bare except for a dust-like whitish micropubescence on 1st and 2nd tergites, and 2nd sternite.

Shape rather robust; head thick, face about as broad as long (70 : 65), roundish square, front, seen from above, rather strongly convex, with a slight longitudinal median furrow; clypeus much broader than long (34 : 24), touching the eyes only with its extreme lateral corner, with its basal half strongly arched; its obtuse angled apical emargination very feeble, only two thirds as broad as the distance between the antennal grooves (10 : 16); flagellum claviform, its 2nd joint distinctly shorter than the 1st, beneath nearly as long as distally thick; shape of the mandibles normal, showing regular teeth; thorax hardly converging in front, pronotum with its lateral corners obtuse-angled and with its anterior edge rounded off; mesonotum as long as broad (46 : 46); postscutellum without carina; propodeum without edges, its backs concave. 1st tergite with its white edge somewhat bent upwards, strongly depressed across before the latter; lamella of both 2nd tergite and 2nd sternite with a row of strong, elongate, translucent, yellowish points, the shallow ends of which do not reach the end of the lamella, the intervals between these points somewhat raised; 2nd sternite in profile strongly convex in front, less behind. Thorax above with strong deep points, the intervals partly less and partly more wide than, but on the average as large as the points, brilliant, without shagreen, with rather sparse, tiny, micropunctation. Punctation of the pleurae and the propodeum similar, that of the mesepimerae less strong, with thickly micropunctate, slightly dullish, intervals. Punctation of the head similar; clypeus basally with very dense, tiny, in the middle with rather sparse and rather strong, for the rest with denser and feeble, punctation. 1st tergite with irregular, partly very dense and partly very remote, less strong punctation, the intervals with dense but superficial microsculpture, moderately shining, in front of the white end with an irregular row of strong points; 2nd tergite with distinct microsculpture, rather dullish, with rather dispersed and irregular, shallow punctation, but distinctly less than that of the mesonotum and hardly larger than that of the 1st tergite; 3rd tergite behind with scattered, rather strong, shallow points; 2nd sternite somewhat more shining, its punctation somewhat stronger and less shallow than that of the 2nd tergite. 4.75 mm.

♂. Colouring and hair as in the ♀, except that the pronotum has a black, not orange, hind patch, the propodeum is black and the 2nd sternite clouded with black; mandibles

mostly white; the 2 last joints of the flagellum yellowish; tarsi testaceous, claw joints of the middle and hind tarsi brown; the silvery hair on the face is still more developed, and the fine whitish pubescence covers the clypeus totally. Clypeus rather opaque, with its microsculpture more developed and the punctation denser than in the ♀; for the rest the sculpture as in the latter. Face somewhat broader than long (66 : 60), rather strongly converging below; antennae as in the ♀, the last 2 joints of the flagellum tiny, the last (12th) tuberculiform seen from above, only as long as broad, triangular, pointed as seen in profile, pressed close to the foregoing joint and reaching only the end of the 10th joint, so that it may be easily overlooked. 4.5 mm.

Types: 1 ♀ (holotype) and 2 ♂♂ (allotype and paratype), Kurnub (30 km ESE Beersheba, Negev), 1.V (H. Bytinski-Salz leg.), coll. m. and coll. Bytinski-Salz, respectively.

Genus *Microdynerus* Thoms. 1871

(Type: *M. exilis* [H.-Sch., 1839]. Desig. by Jonas, 1937)

Microdynerus **latro** n. sp. ♀

Exceedingly resembling *Micr. exilis* ♀ by its shape, its general sculpture, and especially by the polished and sparsely punctate clypeus. The chief differences are as follows: Face more longish (length: width = 59 : 51, in *exilis* = 62 : 58), clypeus somewhat shorter (20 : 30, in *e.* = 21 : 28), its emargination much broader (in proportion to the distance between the antennal pits = 10 : 10, in *e.* = 6 : 9), POL : OOL = 9.5 : 6 (in *e.* = 9 : 8); mesonotum distinctly longer (length : width = 51 : 36, in *e.* = 55 : 42); lamella of the 2nd tergite noticeably narrower, ivory white (in *e.* yellowish); punctation somewhat finer and somewhat more distant in *e.*, especially on the base of the 2nd sternite, yet on the distal part of the latter much stronger than on the mesosternum (in *e.* not or hardly so); pronotal corners obtusely angled, not dentiform as in *e.* For the rest as in *exilis* ♀.

Holotype: 1 ♀, Jericho, 22.III.1931 (Bodenheimer leg.), Zool. Museum Berlin.

Genus *Parodontodynerus* Bluethgen, 1938

(Type: *Odynerus ephippium* [Klug, 1817]. Orig. desig.[5])

Parodontodynerus ephippium **aramaeus** n. ssp. ♀

Differs at a glance from *eph. eph.* ♀ by the striking coloration with a great deal of red: the deep yellow of the markings is largely suffused with orange red on the head (clypeus, frontal and temple patches, and orbital band) and on both mesopleurae and postscutellum; pronotal band, tegulae, parategulae, 2 spots on the scutellum, propodeum laterally to a large extent, the basal sides of 1st tergite, the first sternite totally, and the middle of the 2nd sternite largely, orange red; antennae ferruginous, scape above brownish, flagellum above except the first 2 joints black, beneath distally darkened; trochanters and femora ferruginous, tibiae yellow, stained ferruginous, tarsi testaceous; wings strongly dusky. 1st to 5th tergites, and 2nd and 3rd sternites, with broad yellow apical bands, 4th sternite with a narrow incomplete one.

Punctation of the body much coarser than in *eph. eph.* ♀, especially on the 2nd tergite and on the tegulae.

Holotype: 1 ♀, 'Ein Gedi (Western shore of Dead Sea), 8.IV.1951 (J. Wahrman leg.), coll. Hebrew University, Zool. Dept., Jerusalem.

This subspecies is a connecting link between *Par. ephippium anatoliae* (G.S., 1951), with its strong punctation, and *Par. ephippium rufinus* (Kost., 1940), with its red ground-colour.

Genus *Euodynerus* Bluethg., 1938
(Type: *Euodynerus dantici* [Rossi, 1790]. Orig. desig.[6])
Subgenus *Pareuodynerus* Bluethg., 1938
(Subgenotype: *Euodynerus notatus* [Jur., 1807]. Orig. desig.[7])

Euodynerus (*Pareuod.*) *posticus punctatissimus* (G. S., 1951) var. **nahariensis** n. var.

2 ♂♂ *posticus* (H.-Sch.) from Nahariya (10 km N. of Acre; 11.VI, H. Bytinski-Salz leg.) show the strong and close punctation on the tergites that is the distinctive character of the subspecies *punctatissimus* ♂ (loc. typ.: Gyaur daglari, Anatolia[8]), but while in the type specimen (Unicum) the colouring is said to be as in *p. posticus* ♂, the 2 ♂♂ have additionally 2 yellow spots on the scutellum, and 2 discoidal patches on the 2nd tergite; the yellow marks on the propodeum are well developed.

Undoubtedly conspecifical is a richly yellow coloured ♀ from Ras el Nakura (12.IX, the same collector) with the following characters: bright yellow are most of the clypeus, orbital streaks reaching from the clypeus to the beginning of the sinus, a cuneiform patch along the interior border of the upper eye lobe, and a spot on the vertex at the hind end of the latter, large streaks on the temple, the scape (above slightly reddened); on the mesonotum additionally 4 longitudinal streaks (along the parapsidal lines, shortened in front and behind, and 2 along the tegulae); scutellum with 2 quadrangular patches; the marks on the mesepimerae and propodeum large; disk of 1st tergite yellow with a pentagonal emargination; bands of 2nd to 5th tergites broad, 2nd moreover with 2 rather large square patches, yet disk of 2nd sternite with a single small spot on the right side only; femora mostly yellow.

(A ♀ from El Hamme has been labelled by A. Giordani Soika as "*ypsilon Kostyl*").

Holotype: 1 ♂ from Nahariya, c.m. Paratype: the other ♂ from Nahariya. Allotype: ♀ from Ras el Nakura, in coll. Bytinski-Salz (Tel Aviv).

The ♀ of *punctatissimus typicus* will be described in another paper.

Genus *Deuterepipona* Bluethg., 1951
(Type: *Pseudepipona jonia* [Sss., 1856]. Orig. desig.[9])

In this genus I may place, at least provisionally, all almost bare *Pseudepipona* species (to be understood sensu stricto, not = *Lionotus* Sss.) which have the propodeal cross-edge well developed, without toothlike processus of the lateral edges of the propodeum, and with the mandibles of the ♂♂ simple (not notched).

Deuterepipona herzi **enslini** n. ssp. ♀

The specimen in question agrees almost completely with the description of *Odynerus* (*Lionotus*) *herzi* F. Mor. 1895 (loc. typ.: Sumbar, Transcaspia). G. Kostylev, however, has communicated that in true *herzi* "les espaces entre les points des mésopleures sont bien visibles", while in my specimen the rather strong punctation of the mesopleurae is extremely dense, with the somewhat raised intervals linear. Further differences are as follows: lateral corners of the pronotum obtuse angled, not "rectangular"; the bright yellow colouring of the body still more enlarged: mesepimerae nearly totally yellow; propodeum laterally with broad yellow patches; both 5th and 6th tergites and sternites with broad, bisinuate, not abbreviated fasciae, 7th tergite with a yellow patch,

coxae I totally, II and III in front, yellow, trochanters I and II yellow, III brown; femora I and II totally, III partly, yellow. 8 mm (total).

Holotype: 1 ♂, Jericho, 20—28.IV.27 (E. Enslin leg.), coll. m.

Genus *Pterocheilus* Klug, 1805

[Type: *Pter. pallasii* Klug, 1805. Desig. by Ashmead, 1902 (not *Pter. phaleratus* [Panz., 1797] "desig. by Blanchard, 1840", as R. Bohart erroneously stated in 1951)[10]].

Pterocheilus albidus Giord. Soika, 1941 ♂, ssp. **aramaeus** n. ssp. ♂♀

♂. Differs from *a. albidus*[11] ♂ (compared with the specimen from Porto Bardia, Mus. Genova) as follows:

ssp. *aramaeus*

Upper half of clypeus seen in profile moderately convex.

Outline of the lateral areas of the propodeum seen from above distally with a sharp corner.

1st tergite seen from above less short, with its horizontal portion, seen in profile, as long as the basal portion, the transition between them roundish obtuse angled.

Punctation of the mesonotum on the average noticeably finer, mingled with points of different size, with the intervals mostly smaller or much smaller than the points, even on the distal part of the mesonotum, and shiny, but the surface on the whole, seen with the naked eye, dullish.

Mesepimerae with dense strong punctation, the intervals mostly smaller than the points, shining, but the surface on the whole rather dullish.

Clypeus with distinct shagreen, even above in the middle, dullish throughout.

Femora basally to a rather great extent piceous.

ssp. *albidus*

Upper half of clypeus seen in profile strongly convex.

Outline of the lateral areas of the propodeum seen from above distally rounded off.

1st tergite seen from above distinctly shorter, horizontal portion, seen in profile, only half as long as the basal portion, with the transition less curved, approximately convex.

Punctation of the mesonotum rather coarse, points mostly of equal size, in the distal portion with many intervals as wide as the points or even somewhat wider, and brilliant; mesonotum seen without a lens distinctly shining.

Mesepimerae with stronger but less dense punctation, the intervals mostly wider than the points, up to twice as broad as the latter, and polished.

Clypeus with obsolete shagreen, above in the middle rather smooth and shining, for the rest with feeble and fatty lustre.

Femora basally not or hardly darkened.

For the rest as in the specimen from Porto Bardia, that is, with the mandibles notched, the 3rd to 5th sternites fringed, the temples with tiny hairs, and the fore tergites only with micropunctation, without additional regular points.

Holotype: 1 ♂, Kfar Yeroham (Negev), 6.IV.1854 (Fishelsohn leg.), coll. m.

♀. Evidently this ♂ and a series of ♀♀ from the Negev belong together, considering the conformity of structure, sculpture, and hair. There is only a sexual dimorphism concerning the colour of the markings of both head and thorax: ivory white in the ♂, and dark red in the ♀. These ♀♀ agree fully with the description of *Pter. sempti* G. S., 1943, from Biskra (R. Meyer leg. III.31[12]). Consequently I feel no doubt that *sempti* is conspecific with *Pter. albidus albidus*. Subspecifical differences between the ♀♀ from the Negev and the ♀ from Biskra are to be found out only by comparison in natura.

Allotype: 1 ♀, Urim, 15.V (coll. Bytinski-Salz). Paratypes: ♀♀: Urim, 15.V (coll. m.); Beersheba, 24—31.III (leg. Bytinski-Salz and Theodor, in coll. Bytinski-Salz).

Pterocheilus **paravespoides** n. sp. ♂♀

♀. 18 mm. Black and orange red. Shape stout, thorax only a little longer than wide, strongly converging in front, abdomen short, largely oval. Thorax almost bare, temples with tiny hair, 1st and 2nd abdominal segments without hair but with microscopical brownish pruinosity, head large, face wider than long (172 : 146) but not enlarged behind the eyes, hind edges of the temples strongly obtuse angled, vertex with 2 puncti-

form foveae, each behind a lateral ocellus; antennae long and slender; labial palpi large, polished, 1st joint from its thin stalklike base strongly enlarged distally, 2nd and 3rd joints broad, rather strongly bent in profile, distally, the 3rd also basally, narrowed, both fringed on both edges with long, dense, curved golden bristles. Pronotum bordered in front with a raised carina forming on both ends, seen from above, a sharp tooth, but the corners, seen from in front, roundish rectangular; parapsidal furrows reaching the pronotum; scutellum swollen in front, postscutellum, seen from above, extremely narrow; propodeum simple, everywhere rounded off. 1st tergite about twice and a half as wide as long, disk without engraved longitudinal line, 2nd tergite with its apex narrowly impressed, both with a microreticulate dullish surface with scattered, fine shallow points; sternites rather brilliant, with shallow microsculpture and disperse, moderately fine, punctation.

Deep black, on the mesonotum with a bluish tinge; orange red are: clypeus, frontal keel, frontal area, a broad orbital band filling up the sinus, both temples and mandibles for the most part, scapes, prothorax, mesepimerae, a patch on the mesopleurae above, 2 hooked spots on the base of the mesonotum, connected medio-distally by a cross patch, tegulae, parategulae, scutellum, postscutellum, median segment, except for a triangular area in the middle, 1st segment except a laterally narrowed black band on its end, and a spot on its extreme base, 2nd tergite (with a black spot distally), 2nd sternite behind its basal cross-furrow, and legs; trochanter I red, both II and III brown; wings strongly dusky, veins and stigma dark brown.

Clypeus much broader than long (103 : 76), with the free lateral edges straight, and the end narrow (about $\frac{2}{3}$ of the distance between the antennal grooves, 21 : 27) and hardly emarginate, its surface rather dullish, with a fatty lustre, distinctly shagreened, its punctation strong, but shallow, in the middle rather remote, for the rest dense; front with strong and mostly very dense, vertex with more or less scattered punctation, on the latter with brilliant, rather remotely micropunctate intervals; temples with similar, somewhat stronger, punctation. Mesonotum with strong, scattered, behind very distant, punctation, the intervals strongly brilliant but by a nearly imperceptible shagreen with a slightly fatty, bluish tinge, and rather remotely micropunctate, the fore half of the disk having a slightly impressed, narrow smooth longitudinal band in middle which diverges anteriorly; scutellum with strongly contrasting, coarse and very dense punctation, except for its rather remotely punctate and shining anterior part, without median furrow; backside of the postscutellum and the whole propodeum shining, only with microscopical sculpture, except for the uppermost part of the former bearing a row of strong points, and the rather densely punctate upper lateral areas of the propodeum; mesopleurae with coarse dense punctation, with the intervals mostly much narrower than the points, only below becoming wider, and shining, nearly without microsculpture; mesepimerae with coarse punctation, the intervals being partly less and partly more wide than the points, shining, superficially microsculptured.

Both tibiae and tarsi very spinose, especially those of the fore legs; claws beneath before the middle with a long strong curved hook, and basally with an acute tubercle.

Holotype: 1 ♀, "5 km East of Gvulot" (Western Negev), 8.IV, leg. coll. H. Bytinski-Salz. Paratype: ♀, Kfar Yeroham, 23.V (leg. Bytinski-Salz), coll. m.

The collector encountered the type specimen while it was entering its burrow in a hard dry loess soil and carrying a yellow coloured prey that seemed to be a larva of *Schistocerca gregaria* of the 3rd larval stage.

This ♀ agrees structurally completely with *Pter. fausti* F. Mor., 1873 (loc. typ.: Krasnowodsk), but differs visibly by the quite diverse colouring, and by the divergent sculpture of several parts of the body (punctation much stronger, and denser on vertex, mesonotum in front, scutellum, and mesopleurae; clypeus distinctly shagreened, and dullish). To this group belong moreover *Pter. menzbieri* Kost. 1940, and *Pter. lutorius* G. S., 1942[13], and perhaps likewise *Pter. rubrocingulatus* Schulth., 1940.

♂. Mandibles not notched, with 3 teeth, the uppermost broad, short, with straight edge, the middle one rather broad but hardly protruding, with triangular end; pilosity of temples, tergites and fore sternites, sculpture of the tergites, development of the parapsidal furrows, structure of the temples, pronotum, postscutellum, and propodeum, as in the ♀; scutellum with an impressed median line; 3rd to 5th sternites each with a brush of black bristles in its median third; labial palpi thin, the 1st joint long stalk-like, distally slightly broader, the sparsely hairy 2nd and 3rd each as long as the foregoing one, the 3rd needle-shaped; flagellum rather long, conspicuously thickened towards the end, its 2nd joint about three times, and its 3rd joint twice as long as broad, the joints of the spiral small, short. Shape much more elongated than in the ♀, abdomen elliptical; face moderately broader than long (112—98), slightly converging below, clypeus large, nearly as long as wide (50 : 57), slightly convex above, flattened below, with its emargination much broader than the distance between the antennal grooves (18 : 12), shallow, obtuse angled, with obtuse lateral corners. Punctation of both mesonotum, and front part of the scutellum, much denser than in the ♀.

Black; clypeus, frontal keel, frontal area, and an orbital band reaching from the clypeus into the sinus, whitish yellow, the latter reddened above; temples above with an orange spot, mandibles reddish testaceous with a yellowish basal spot outside; scape and legs light orange, flagellum black with its 1st joint beneath, and its 2nd joint above to a great extent, orange; red coloration of both thorax and abdomen less intensive than in the ♀, only light brownish orange, and the same are: pronotum (totally, in middle tinged with yellowish), mesepimerae, scutellum (except its base), upper border of the back of the postscutellum, tegulae, parategulae, large lateral patches on both propodeum, and base of 1st tergite; 2nd tergite entirely except for a rather large roundish black spot on its disc, 2nd sternite, and broad band on the ends of the 4th to 6th tergites. Wings less dusky than in the ♀, stigma dark testaceous. Clypeus without pilosity. 11 mm.

Allotype: 1 ♂, Urim (Negev), 5.V (H. Bytinski-Salz leg.), coll. m.

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13. id., 1942, *Boll. Soc. Ent. Ital.*, **74**, 56-57. Fig. 1 (with misprint: ♀ instead of ♂), loc. typ.: Djebel Elba. See also my paper "Ueber 3 mangelhaft beschriebene *Pterocheilus*-Arten aus Aegypten", 1955, *Doriana*, **2**, 2—3.

THE SPHECIDAE (HYMEN.) OF EREZ ISRAEL.

I. (SUBFAM.: SPHECINAE, NYSSONINAE; TRIB.: *BEMBICINI, STIZINI*)

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ABSTRACT

In this first part the following genera are treated as occurring in Erez Israel: *Ammophila* (25 species), *Sphex* (22 species), *Sceliphron* (4 species), *Bembix* (12 species), *Bembecinus* (6 species), *Stizoides* (6 species), *Stizus* (14 species).

The following species and forms are described as new: *Ammophila* **maris-mortui** ByS., *A. algira* Kohl ab. **bituberculata** ByS., *A.* **sacra** ByS., *A.* **pseudonasuta** ByS., *Bembix cinctella* Hdl. ssp. **enslini** ByS., *B.* **holoni** ByS., *B.* **joeli** ByS., *B. dahlbomi* Hdl. ssp. **sabulosa** ByS., *B. turca* Dahlb. ssp. **picturata** ByS., *Stizoides* **verhoeffi** ByS., *Stizus ruficornis* F. ssp. **eremicus** ByS.

The following sexes are described for the first time: *Ammophila honorei* Alfieri ♂, *Sphex melanocnemis* Kohl ♂, *Stizus hebraeus* Balt. ♂.

INTRODUCTION

The material on which this paper is based consists of over 2300 specimens which were mainly collected by the junior author during the last 15 years. A few specimens forwarded by O. Theodor, J. Wahrman, J. Kugler and J. Palmoni are also included, as well as several records of P.M.F. Verhoeff who collected Sphecidae in Israel during May—June 1951; this material is quoted only in those cases where it represents species, localities or dates not recorded before.

Bodenheimer (1937), in a first survey of the Fauna of Palestine, enumerates 81 species of Sphecidae, most of which could be verified. Cases of obvious misidentification are corrected here. Today more than 250 species and forms of Sphecidae are presented in this paper, including many new species and new forms. The species not mentioned before are marked with an asterisk (*). The following 14 genera are new for the fauna of Israel: *Pseudoscolia*, *Kohlia*, *Argogorytes*, *Nysson*, *Larra*, *Liris*, *Larropsis*, *Tachytes*, *Prosopigastra*, *Gasterosericeus*, *Laphyragogus*, *Palarus*, *Psen*, and *Pemphredon*.

H. Bytinski-Salz has described the genera *Ammophila*, *Sphex*, *Sceliphron*, *Bembix*, *Stizoides*, *Stizus*, *Kohlia*, *Sphecius* and *Philanthus*, while J. de Beaumont has described all the remaining genera except *Belomicrus* and *Oxybelus*, which were kindly determined by the specialist in this group, P. M. F. Verhoeff, and also members of the genus *Miscophus*, which were determined by N. F. de Andrade. All authors describe new species and forms under their own names. Types, if not stated otherwise, are in the collection of H. Bytinski-Salz, paratypes, if available, in the collections of the other authors mentioned.

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The junior author expresses his most sincere gratitude to Dr. J. de Beaumont for his constant useful advice in nomenclatural questions and the determination and revision of a large number of doubtful specimens.

An extensive faunistic analysis of the Sphegid fauna of Israel will be given at the end of the paper.

When the first part of this work was ready for press, we received the paper of Balthasar: Ein Beitrag zur Kenntnis der Palaestinensischen Spheciden; 1952, *Acta Ent. Mus. Nat. Pragae*, **28**, published 1953, distributed summer 1954. He enumerates 52 species, among them 6 new ones, which were collected by the late J. Houška during 1941—45 chiefly around Jericho and Jerusalem. We have included the material in the first part as far as space permitted, but the reasons for putting some of the new species in synonymy must be left for later.

AMMOPHILA

Ammophila (*Podalonia*) *tydei* Guill.

♂♂♀♀: Jericho 5.XII—5.IV, Jerusalem 20.VI, Ramle 24.VI, Rosh Ha'ayin 26.IX, Bat Yam 14.III—3.VI, Holon 3.V, Rehovot 12.V, Beror Hayil 1.VI, Tel Aviv VII—X, Beeri 1.VI, Urim 20.XI, Revivim 15.VIII, Kfar Yeroham 15.V, (leg. Fishelson), Wadi Fukra 12.VI, Ramat Gan 6.V—12.VIII, 18.XI, Herzliya 17.VI, Binyamina 5.VIII, 15.XI—1.XII, Nahariya 1.VI, Deganya 3.IX.

Distribution: S. Europe, N. Africa, Israel, Syria, Iran, Turkestan, Tropical Africa to Cape, Madagascar. FE: Med/SS/Ethiop.

Ammophila (*Podalonia*) *fera* Lep. (Bodenheimer 1937 as *A. morawitzi* Andr.)

I have not seen this species, but Dr. de Beaumont informs me that he has seen a specimen in the Zoologische Staatssammlung Munich labelled "Palaestina" (concerning the reliability of these labels see *Bembix palaestinensis* Lohrm.).

Distribution: Balkans, Asia Minor, S. Russia to Caucasus. FE: Eastmed.

**Ammophila* (*Podalonia*) *atrocyanea* Ev. v. *massinissa* Mor.

♂♀♀: Beersheba 24. III, leg. Theodor, Bir 'Asluj 7. III, Naqb Sehali (Negev Mountains) 1. IV, leg. Wahrman, in coll. Verhoeff.

Judging by the more pronounced punctation of the mesopleurae and the size, ♂ 13 mm, ♀ 15 mm, both specimens seem to belong to Morice's variety. The ♀ has the abdomen completely black with blue metallic hue. It is possible that v. *massinissa* Mor. will ultimately prove to be a good species, but I have no Asiatic material of *A. atrocyanea* Ev. for comparison.

Distribution: *A. atrocyanea* Ev.: Urals, Baku, Bukhara, Altai, Egypt (according to Alfieri 1946). *A.a.* var. *massinissa* Morice: Algiers, Sinai, Israel. FE: Southmed.

Ammophila* (*Podalonia*) **maris-mortui ByS. spec. nov. (?Balthasar 1954: *A. hirsuta mervensis* Rad.)

♀: Completely black, head and thorax covered with black hair. Mouth parts as long as the mandibulae; mandibulae (Figure 1a) with a strong tooth in the apical third, followed by a smaller one near to it. Clypeus slightly elevated, apical border slightly rounded, angulate laterally terminating in a small tooth, then retracted and protruding again towards the insertion of the mandibulae. Surface lucid with strong coarse punctation; face with similar but finer punctation; these points are arranged in irregular rows, converging towards the anterior ocellus; occiput more sparingly punctate. Antennae inserted close together, the distance between the inner edges of the antennal

base being about 1/3 of the diameter of the base. Distance between the centres of the antennae to that from the antennae to inner ocular edge as 2:5. First antennal joints 0.7; 0.1; 1.1; 0.7 mm.

Prothorax rounded, lucid, punctate in the middle, striate at the sides; mesonotum lucid with a depressed middle line, the whole surface being strongly punctate with coarse, elongate, somewhat confluent points. Tegulae impunctate. Scutellum lucid, impunctate at its base, with a few coarse points at its apex. Postscutellum lucid with a few longitudinal ridges. Propodaeum coriaceous, the edges of the disc having almost the same structure. Sides of the propodaeum with coarse rugose lines converging posteriorly. Petiolus as long as the hind tarsus, lucid. Abdomen without sculpture.

Fore coxae without apophysis, fore metatarsus asymmetrical, the other tarsal joints less so. Tarsal claws without tooth and with a small but distinct pulvillus. Wings uniformly dark brown. Radial sector of the 2nd cubital cell about 1/3 of its length along the cubitus. 1st and 2nd transverso-cubital veins straight, the 3rd curved outwards at its base (Figure 1b). 14—18 mm.

♂: Black; head covered with black, thorax with greyish hairs; clypeus and face covered densely with silvery-white pubescence; the legs and abdominal tergites slightly greyish pruinose.

Structure similar to the ♀, except: mouth parts almost twice as long as the mandibles. Clypeus flat, shining with reticulate microsculpture, and a few scattered insertion points of hairs, without large points. Apex slightly incurved in the middle but less than in *ebenina*. First antennal joints: 0.5; 0.12; 0.65; 0.5 mm. Punctation of the vertex, pro- and mesonotum, slightly less dense than in the ♀, the points more rounded. Scutellum striped longitudinally. Length of the petiolus = metatarsus + 1/2 2nd tarsal joint. Pulvillus almost 2/3 the length of the claw. Wings hyaline with a dark fuscous apical band, 2nd cubital cell less constricted at its radial end, the two sectors as 2:1. Length 17 mm.

Holotype: ♀ Old Jericho Road 17.III. Allotype: ♂ Jerusalem—Jericho Road, old Wadi Kelt Police Station 15.IV. Paratypes: ♀♀ 'Ein Gedi, 16.III, Ras el Sueira 9.IV (leg. Fishelson), Nahal Nafha, 15 km S.E. from 'Avdat (leg. Wahrman, in coll. Verhoeff). The paratypes of 'Ein Gedi are old specimens, with the wings tattered, tarsal combs worn and the mandibulae chewed up; therefore also the apical teeth of the clypeus are less prominent than in the fresher holotype.

Distribution: Israel (Dead Sea region). FE: Endemic (SS.)

I place this species near *A. atrocyanea* Ev. because of the presence of 2 lateral teeth at the edge of the clypeus. The ♀ differs from the latter species by its colour, by the different form of the apex of the clypeus, by other proportions of the basal antennal joints, by the structure of the propodaeum, and by the different form of the 3rd cubital cell. It differs from *A. hirsuta* ssp. *mervensis* Rad. by the presence of a pulvillus, by the different form of the clypeus, by different proportions of the antennal joints, by the edges of the disc of the area dorsalis of the propodaeum which is clearly striate in the latter species, by the punctation of the mesonotum, the points of which are more circular in *mervensis*, and by the form of the 3rd cubital cell.

The ♂ differs from *A. atrocyanea* Ev. by its different colour, clypeus, and propodaeum; from *A. ebenina* Spin. by its colour, different clypeus, broader face, different punctation of the thorax, longer 3rd antennal joint, and different genitalia. From

A. schmiedeknechti Kohl by the entirely different form and sculpture of the clypeus, different sculpture of the propodaeum, broader 3rd cubital cell, and different genitalia. From *A. hirsuta* ssp. *mervensis* Rad. by its colour, less punctate clypeus, lighter wings with more pronounced apical band, longer pulvilli, and different genitalia (Figure 1c,d).

**Ammophila* (*Podalonia*) *ebenina* Spin.

1 ♀ Jericho 14.III.

De Beaumont (1952) has already pointed out that this is the oldest name for the species described by Morice as *A. micipsa*. It is not identical with *A.* (*Podalonia*) *hirsuta* Scop. var. *mervensis* Radz., as suggested by Kohl (1906), Roth (1928), and Alfieri (1946), from which it differs among other characters by its striate propodaeum and the presence of a pulvillus in the ♀.

Distribution: N. Africa, Israel, Syria, Caucasus, Turkestan. FE: Med/IT.

**Ammophila* (*Podalonia*) *affinis* Kirby

♀♀: Tel Aviv X, Urim 15.V, Bir Asluj 10.IV.

Ammophila (*Eremochares*) *algira* Kohl (syn.: *A. caelebs* Kohl) and ab. **bituberculata** ByS. ab. nov.

Kohl (1901) described the ♀ of *A. algira* from Algiers (Oasis Biskra) and the ♂ of *A. caelebs* from Egypt (Fayum). He already points out that this specimen may be the ♂ of *A. algira* Kohl. Roth (1928) describes the ♂ of *A. algira* Kohl from Algiers (Ghardaia), which however differs from the description of *A. caelebs* Kohl by the presence of 2 conical tubercles on the mesonotum; the other characters agree as well with the description of *A. caelebs* Kohl, as with those of the ♀ of *A. algira*. Because of this difference in the mesonotum, Alfieri (1946) also considers *A. caelebs* as a species distinct from *A. algira*.

More material from Israel and N. Africa, however, proves the curious fact, unique among the genus *Ammophila*, that regardless of sex and locality there occur 2 different sculptural forms among *A. algira* Kohl: one with smooth mesonotum, and one with bituberculate mesonotum. The latter I am calling: ab. *bituberculata* ab. nov., to draw the attention of the taxonomists to this interesting variety. The typical form of the mesonotum of ab. *bituberculata* is shown in Figure 2c, but I have also a transitory specimen with the tubercle less elevated and the points more blunt. In Figure 2 a, b, d, e I depict also the clypeus (♂♀), anterior tarsus (♀) and genitalia (♂) of Israeli specimens. In 1 ♀ the 2nd recurrent nerve is almost interstitial, in 2 ♀♀ and 1 ♂ it enters the proximal quarter of the 3rd cubital cell.

A. algira Kohl: ♂♀♀: Kfar Yeroham and 6 km East of this place 20— 29. IV.

A. algira ab. *bituberculata* ByS. Holotype: ♀ Kfar Yeroham 20. IV.46. Allotype: ♂ Algiers (Ghardaia) mentioned by Roth (1928). Paratype: 1 ♀ Algiers, El Kantara 18.V.54, leg. Linsenmaier, in coll. de Beaumont. Mons. Paul Roth also wrote to me that he caught several ♂♂ of this form at Biskra. The ab. *bituberculata* ByS. therefore occurs in the ♂ as well as in the ♀ and in Algiers as well as in Israel.

Distribution: Algiers, Cyrenaica, Egypt, Sinai, Israel. FE: Southmedit.

* *Ammophila* (*Eremochares*) *lutea* Tasch.

♂♀: Halutsa 3.VI., Kas el Muhalla (Negev Mountains) 12.IV (leg. Fishelson).

Distribution: Sudan, Egypt, Sinai, Israel, Transcaspia, Iran. FE: SS/IT.

Ammophila (*Eremochares*) *dives* Brllé.

♀: Kallia, IV.

Distribution: N. Africa, Arabia, Israel. FE: Med./SS.

Ammophila* (*Eremochares*) **sacra ByS. spec. nov.

♀♂: Head, thorax, 1st abdominal sternite, dorsal side of 1st abdominal tergite, tergites 4—6, black. The following are red: mandibles (except at the tips), edge of the clypeus, funiculus (darker in the ♂), tegulae, apical and lateral parts of tergite 1, tergites 2 and 3, fore and middle legs (except for coxae and trochanters). Hindlegs above— black, below — dark brown. ♀: 22—24 mm; ♂: approximately 19 mm.

The new species is near to *A.* (*Eremochares*) *dolichostoma* Kohl, from which it may be distinguished immediately by its dark hindlegs. Its structure almost agrees with *A. dolichostoma* Kohl, but differs in the following points: clypeus more elongate, its sides more straight towards the base of the mandibles (Figure 3a ♂; 3b ♀); proportions of 3rd: 4th antennal joint in the ♀ as 3:2 (in *dolichostoma* 1:1/2); episternum more rounded, not enlarged in an angle, scutellum and postscutellum elevated without median impression, anterior tarsal joints 2+3 more asymmetrical.

Holotype: ♀ Jerusalem 26.V.40; allotype: ♂ Rosh Pina 9.V.40; (last abdominal segments lacking). Paratypes: ♀♀: Kfar Yeroham 18.IV; Djebel Hureishe (Negev Mountains) 21.IV (leg. Fishelson); Syria: ♀ Kussein, 13 km NE of Damascus 6.V; Turkey: ♀ Aksu, 10 km S. Marash 16.IV, both leg. Schmidt, in coll. de Beaumont.

Distribution: Israel, Syria, Turkey. FE: Eastmed.

Ammophila (*Coloptera*) *barbara* Lep. and ssp. *judaeorum* Kohl (Balthasar 1954)

Two different forms are present in my material, the one confined to the South and the Negev with entirely black mandibles, tegulae and legs, and the red colour of the abdomen restricted to the 1st tergite and 2nd tergite and sternite = ssp. *barbara* Lep. In the form from the Jordan Valley, the mandibles, tegulae, fore and middle legs, and also part of the hind femora, are red. On the abdomen the red colour covers also the entire 3rd segment and the lateral parts of the 4th = ssp. *judaeorum* Kohl.

Ssp. *barbara* Lep.: ♂♂♀♀: Dorot 18.IV, Beersheba 28.IV, Urim 15.V, Beerot Yitshaq 25.V, Kfar Yeroham 20.IV.

Ssp. *judaeorum* Kohl: ♂♂♀♀: Djiftlik (Wadi Fara) 19.IV, Jericho 9.IV, Jerusalem— Jericho Road, km 32, 18.IV, 5 km S. of Kallia 17.IV, Wadi Kelt 10.3 (Houška).

Ammophila (s. str.) *haimatosoma* Kohl

♂♂♀♀: Wadi Raman, 30. III, Arnon River Delta 7.VI, Kallia 16.VIII, Wadi Kelt 19.VI, El Hamme 18.IV.

The majority of the specimens have the thorax entirely reddish brown.

The ♀ from Wadi Kelt differs in several respects: extremely large — 31 mm; sides of the 1st tergite and whole 2nd tergite red; proportions of antennal joints 2, 3, 4 as 0.3 : 1.45 : 0.6 mm (in *haimatosoma* ♀ as 0.25 : 0.8 : 0.5); inner side of the fore basitarsus without long bristles (present in *haimatosoma*). These differences indicate a new species nearly related to *haimatosoma*, but I refrain from naming it as long as no ♂ is available.

Distribution: N. Africa, Israel, Cyprus. FE: SS.

Ammophila (s. str.) *gracillima* Tasch.

♂♂♀♀: 14 km South of Beersheba 6.VI, Urim 12.V, Kasr Muhalla (Negev Mountains) 12.IV (leg. Fishelson).

Distribution: N. Africa to Abyssinia, Israel. FE: SS/Ethiop.

* *Ammophila* (s. str.) *producticollis* Morice

♀♀: Kfar Yeroham 20. VIII, Wadi Raman 30. III.

Distribution: Algiers, Egypt, Sinai, Israel. FE: SS.

**Ammophila* (s. str.) *quadraticollis* Costa

♂♂♀♀: Jaffa (coll. Verhoeff); Ra'anana 26.X, Ramat Hasharon 19.VII, Ascalon 17.VII, Beersheba 12.VI.

Distribution: N. Africa, Sinai, Israel. FE: Med.

**Ammophila* (s. str.) *hemilauta* Kohl

♂♀: Old Jericho Road 5.IV.

Distribution: N. Africa, Israel. FE: SS.

Ammophila* (s. str.) **pseudonasuta ByS. spec. nov. (syn.? *A. nasuta* Alfieri (1946) nec. *A. nasuta* Lep. (1845)).

♂: Head and thorax entirely black (*nasuta* (*n.*): pronotum reddish). All coxae and trochantera black (*n.*: chiefly reddish), rest of the fore and middle legs reddish. Hind femora and tibiae black (*n.*: femora red with distal infuscation, tibiae with the proximal half reddish).

1st abdominal sternite completely black (*n.*: red), tergite black above (*n.*: reddish), 2nd tergite with an elongate triangular spot reaching from the base to the tip; 3rd to 5th tergites with large oval spots towards the base (holotype) or these spots reduced in size (paratype) (*n.*: tergites 2—4 entirely reddish or with thin black longitudinal line). Tergites 6—7 largely pure black on the disc, but reddish at the sides (*n.*: tergites and sternites 6—7 entirely black with pronounced bluish reflex). The whole body covered with a silvery pubescence, chiefly on the clypeus, face, disc and sides of the mesonotum, sides of the propodaeum, coxae and trochantera (*n.*: pubescence much less evident, almost lacking on the mesonotal disc and legs). Pruinosity on the dorsal side of the abdominal segments 1—5 very dense, forming a broad white band (*n.*: less pronounced).

Concerning the morphological characters, the reader may be referred also to Alfieri (1946), Figures 133—136, but not to the text, which at least partially describes characters of *A. nasuta*. The mandibles (Figure 4a) are tridentate with an angular edge below the lower tooth. A large extra inner basal tooth is present. In *nasuta* this tooth is absent, but there is sometimes a very small tooth on the inner edge above the position of the tooth in *pseudonasuta*, visible only from below. Clypeus elongate (Figure 4a), the part below the mandibles trapezoidal, the apical border notched. The inner edges of this notch slightly curved outward and meeting in a distinct angle (*n.*: apical border almost straight, *A. atlantica* (*a.*): semicircularly excised). The distal part of the clypeus much thinner than the base and slightly curved upwards, its edge not thickened (Figure 4b, lateral view) (in *n.*: a distinct acute tubercle present at the tip (Figure 4c), in *a.*: clypeus straight, edge pointed (Figure 4d)). Eyes slightly converging towards the clypeus, face slightly broader than in *n.* (5 : 4.5). POL: OOL = 1 : 1; temples narrower than in *n.* 3rd antennal joint more than twice as long as the 4th (joints 3:4:5 48:20:20) (*n.* : 30:18:18, *a.*: 40:18:18). Clypeus, face and frons shining, with fine reticulate microsculpture.

Configuration and sculpture of the thorax as in *n.* and *a.*, but the striation of the area dorsalis of the propodaeum more clear (*a.*: rugose, not striate). Last abdominal segments much broader than in *n.* and *a.* 8th sternite (Figure 4e) quadrangular, rounded, slightly and broadly excised, not carinate; the apical chitinized part with large points between the microsculpture (*n.*: (Figure 4f) triangular, carinate, slightly notched, *a.*: (Figure 4g) triangular, not carinate, deeply notched, in both species the disc finely punctate).

Genital apparatus (Figure 4h) extremely large: 3.5 × 2.2 mm. The proportion between the length of the abdomen incl. petiolus (13—14 mm) and the genital apparatus as 4 : 1 (*n.* and *a.*: 10 : 1, Figure 4i, k). The different parts of the genitalia are well depicted by Alfieri (1946, Figure 138). The differences from *n.* and *a.* are: valva longer, more rectangular, tip more abrupt; "hook" longer, more slender and ending in a very long spine; middle part also longer.

Venation: the 2 recurrent nerves enter the 2nd cubital cell more apart at the proximal and distal ends of the cell (*n.* and *a.*: more close together).

Length: 21—22 mm (*n.* = 18 mm; *a.* = 20 mm).

Holotype: ♂ Bat Yam 5—21.VI.51, leg. Verhoeff. Paratype: ♂ Gvulot 20.V.46, a mutilated specimen found dead in a spider's web.

♀: Probably as described and depicted by Alfieri (1946, Figures 131, 133) from the Sinai, IV.

Distribution: Erez Israel, Sinai?. FE: SS.

A. pseudonasuta ByS. differs in so many respects from *A. nasuta* Lep. and its ssp. *atlantica* Roth, that it seems incomprehensible that the two species have ever been mixed up. Only the frontal view of the clypeus shows some similiarity, but its profile is already very distinct in the two species. Besides the coloristic differences, which enable to differentiate the two species at once, the more important differential characters are the presence of the large basal tooth on the mandibles, the form of the 8th sternite, the form and enormous size of the genitalia etc. This large size of the genital apparatus is also found in *A. strumosa* Kohl, and to a lesser degree also in *A. hemilauta* Kohl, and it is not impossible that *A. pseudonasuta* is more closely related to these two species than to *A. nasuta* Lep.

Concerning the reference to *A. nasuta* Lep. in Alfieri's paper (1946), the figures of the ♂ (Figures 132, 134—138) clearly refer to *A. pseudonasuta*, but in the description there are several points which clearly refer to *A. nasuta*, as f. i. the bluish reflex of the last abdominal tergites and the triangular tooth at the tip of the clypeus — but perhaps this description was copied from one of the descriptions of *A. nasuta* Lep.? As I have at the moment no possibility of examining these two specimens from the Sinai, I am including them with a slight doubt among *A. pseudonasuta.*

In this connection I also want to point out that *A. nasuta* Lep. and ssp. *atlantica* show so many structural differences (see Figure 4c, f, i and d, g, k), that in my opinion they should be treated as separate species.

**Ammophila* (s. str.) *strumosa* Kohl

♂♀♀: Kallia 17.IV, Jericho 8.IV, Old Jericho Road 5.IV, Jerusalem—Jericho Road, km 32, 18.IV, Beersheba 28.IV.

Distribution: N. Africa, Sinai, Israel, Syria. FE: SS.

Ammophila (s. str.) *heydeni* Dahlb.

♂♂♀♀: Jericho 25.VI, Jerusalem — Jericho Road, km 32, 18.IV, dto km 16, 18.IV, Jerusalem 21.V—19.IX, Binyamina 12.4, Haifa (leg. Verhoeff).

Distribution: S. Europe, N. Africa (except Egypt), Israel, Cyprus, Asia Minor. FE: Med.

None of the ♀♀ have all the legs entirely red as in ssp. *sardoa* Kohl, which also occurs in Cyprus (de Beaumont 1947), but in the majority the hind tibiae are distinctly lighter than in specimens from Europe and Asia Minor.

**Ammophila* (s. str.) *rubripes* Spin.

♂♂♀♀: Jordan, Allenby Bridge, 30.VII, Jericho 26.IV — 2.IX, Wadi Kelt 5.IV — 2.VI, Old Jericho Road 5.IV, Jerusalem 23.VII, Tel Aviv X, Bat Yam 3.X, Ramat Gan 10.IV—12.VI, Gat 10.VIII, Ascalon 15.X, Dorot 27.VI, Beersheba 13.VI, Ra'anana 26.X, Binyamina 20.IV—5.VIII, 15.XI, Haifa 27.VII, Nahariya 11.VI, Tiberias 10.V, Deganya 17.IV—3.IX, El Hamme 18—20.IV.

De Beaumont (1951-52) has pointed out that this is the oldest name for Egyptian specimens of *A. propinqua* auct., and I am using this name also for the specimens from Israel, though, as Dr. de Beaumont communicated to me, the genitalia of both forms are slightly different. The name *A. syriaca* Mocs. may be applied to the Israel form, if it proves distinct. This is also the form which de Beaumont (1949) mentions as *A. propinqua* Tasch. "Forme saharienne".

Besides this form, there are in my material also 2 ♀♀: Kallia 17.IV, Jerusalem—Jericho Road, km 32, 18.IV, which de Beaumont (1949) considers as belonging to his "forme méditerranéenne". It is probably a distinct species from *A. rubripes* Spin., but the synonymy is complicated by the fact that, according to information kindly supplied by Dr h. c. H. Haupt, there is no type material of *A. propinqua* Tasch. in the Zoological Museum of the University of Halle a/Saale, where the collection of Taschenberg is preserved. The types originating from the Sudan seem therefore to be lost, and it is impossible to judge from the original description whether this name could be applied to the "forme méditerranéenne" sensu de Beaumont.

Distribution (of both forms): N. Africa, Sudan, Ethiopia, Sinai, Israel. FE: Med/SS/Eth.

Ammophila (s. str.) *egregia* Mocs.

♀♀: Wadi Menaieh (Negev Mountains) 13.IV (leg. Fishelson), Wadi Fukra 20.IV, 'Ein Gedi 18.IV, Wadi Kelt 24.IV—29.VI, Rosh Haniqra 9.VII—12.IX.

Distribution: Egypt, Sinai, Israel, Syria. FE: SS.

**Ammophila* (s. str.) *erminea* Kohl

♂♂♀♀: Beersheba 6.V, Beit Eshel 20.IV, Halutsa 3.VI, Revivim 3.VIII, Kfar Yeroham 20.VIII, Wadi Fukra 12.VI.

Distribution: Rio de Oro, N. Africa, Red Sea coast, Sinai, Israel. FE: SS.

**Ammophila* (s. str.) *dubia* Kohl

♀♀: Jericho 2.VI, Jordan: Place of Baptism (Al Maghtas) 10.IV.

Distribution: Egypt, Israel. FE: Med/SS.

**Ammophila* (s. str.) *assimilis* Kohl (Balthasar 1954)

♂♂♀♀: Jerusalem—Jericho Road, Old Wadi Kelt Police Station 26.II—25.III, Wadi Nafkh (Negev Mountains) 11.IV (leg. Fishelson), Jerusalem 4.IV—4.V,

Jerusalem 14.IV (Houška), Binyamina 12.IV, 'Afula 25.IV, Tiberias 2—14.IV, Deganya 18.III, 'Ein Gev 5—23.IV, Rosh Pina 9.V.

Distribution: Israel, Syria. FE: Eastmed.

**Ammophila* (s. str.) *honorei* Alfieri

♀♀: Between Nebi Musa and Kallia 18.IV, Judean Desert near Hebron (leg. Theodor), Revivim 12.V, Subeita 9.IV, Kfar Yeroham 3.IV, Hamakhtesh Hagadol 5.III, 'Avdat 18.IV (leg. Wahrman, coll. Verhoeff), El Tureibe 14.IV (leg. Fishelson).

♂: New description: in colour identical with the ♀, but 1st sternite, 1st and 2nd tergite brown; rest of the abdomen black with a strong blue metallic hue. Apex of the clypeus with 2 small teeth as in the ♀, slightly incavated between. Antennal grooves bordered inside by a narrow ridge. Valva of the genitalia as in Figure 5a. 15.5 mm.

Neoallotype: Revivim 12.V. Neoparatypes: ♂♂ 'Avdat 18.IV, in coll. Verhoeff, Beersheba 3.IV, Kfar Yeroham 11—14.IV.

A. honorei is morphologically extremely near *A.* (s. str.) *apicalis* Brllé, but differs by the longer 3rd antennal joint: 3rd : 4th = 5: 3; in *A. apicalis* as 4 : 3, and by its slightly different genitalia (Figure 5b). Of course, the blue colour of the body similar to *Sceliphron targionii* distinguishes this species immediately from all other *Ammophila* species.

Distribution: Sinai, Israel. FE: SS.

SPHEX

Sphex (*Chlorion*) *regalis* Sm.

♂♂♀♀: Jericho 7.VII—25.X, Kfar Yeroham 5.VII—20.VIII.

Bodenheimer (1937) mentions *S. regalis* Sm. var. *kohli* André = *S. funereus* Grib., which probably refers to this species.

Distribution: Egypt, Sinai (= *bicolor* Walk.), Israel, Arabia, S. India. FE: Paltrop.

Sphex (*Chlorion*) *hirtus* Kohl (Balthasar 1954)

♂♂♀♀: Jericho 27.VIII — 12.X, Wadi Kelt 5.IV, Jericho — Wadi Kelt VIII, I (Houška), 5 km South of Kallia 14.II, 'Ein Feshra 15.II, Kallirhoe 7.VI, Arnon River Delta 5.VII, 'Ein Gedi 16.III, Wadi Fukra 26.IV.

Size: ♀♀ up to 38 mm, ♂♂ up to 32 mm.

Distribution: Israel, Egypt, Arabia, coast of the Red Sea and the Persian Gulf. FE: Ethiop.

**Sphex* (*Palmodes*) *occitanicus* Lep. et Serv. ssp. *syriaca* Mocs.

♂♂♀♀: Jerusalem 1.VI — 21.VIII, Ramat Gan 28.IV, Tiberias 8 — 10.V, Rosh Pina 9.V.

Distribution: Israel, Syria, Asia Minor. FE: Eastmed.

**Sphex* (*Palmodes*) *strigulosus* Costa

♂♂: Jerusalem 3.IX, Ramat Gan 6.V.

Distribution: S. Europe, Israel, Asia Minor to Turkestan. FE: Med/IT.

**Sphex* (*Palmodes*) *argyrius* Brllé

♂♂♀♀: Jerusalem 1.VI—21.VIII, Rosh Pina 9.V.

Distribution: whole Mediterranean excl. Egypt, Israel, Asia Minor. FE: Med.

Sphex (*Calosphex*) *niveatus* Duf.

♂♂♀♀: Jericho 2.VI, Bat Yam 5—19.V, Beersheba 4—13.VI, Halutsa 8.VI, Kfar Yeroham 1.VI, Wadi Fukra VIII.

One specimen from Beersheba has the petiolus red.

Distribution: N. Africa to Sudan, Israel. FE: SS.

Sphex (*Calosphex*) *nigropectinatus* Taschbg. (syn. *Harpactopus nivosus* Smith according to Kohl 1890).

Mentioned by Bodenheimer (1937) under the latter name. I have not met with this Palaeotropical species which is likely to occur in Israel, but I suspect a misidentification for the common *S. niveatus*. Honoré (1944) knows of only 2 specimens from Egypt.

Distribution: India, Sudan, Obok, Egypt, Algiers. FE: Paltrop.

**Sphex* (*Calosphex*) *haberhaueri* Rad.

1 ♀: Jericho 2.VI.

Distribution: Israel, S. Russia. FE: Eastmed.

**Sphex* (*Calosphex*) *vittatus* Kohl

1 ♂: Jerusalem 12.V.

As Kohl (1890) has already pointed out, this may be the ♂ of *S. haberhaueri* Rad., a case of extreme sexual dimorphism among the genus *Sphex*.

Distribution: Israel, Caspian Sea. FE: Eastmed.

Sphex (*Prionyx*) *viduatus* Christ.

♂♂♀♀: Jericho 22.VIII, Kallia 15.VIII, Arnon River Delta 7.VI, Beeri 1.VI, Urim 15.V, Bir 'Asluj 8.VII, Revivim 10.X, Kfar Yeroham 5.VII—20.VIII, Wadi Fukra 26.VI.

Distribution: Tropical Africa, India, China, N. Africa, Israel, Asia Minor. FE: Paltrop.

**Sphex* (*Prionyx*) *albisectus* Lep. et Serv.

♂♂♀♀: Jericho 22.VIII, Jerusalem 12.VIII—3.IX, Giv'at Brenner 19.VII, Beror Hayil 1.VI, Ruhama 29.VI, Beerot Yitshaq 25.V, Ramat Gan 10.IV—6.V, Ramat Hasharon 9.VII, Pardess Hanna 14.VI, Binyamina 17.IV, Nahariya 19.VI, Tiberias 10.V, Amir 16.VIII.

Distribution: S. Europe, N. Africa, Israel, Asia Minor. FE: Med.

**Sphex* (*Prionyx*) *songaricus* Eversm.

♂♂♀♀: Jericho 3.IX, Ramle 24.V, Rosh Ha'ayin 26.IX, Pardess Hanna 9.IV, Nahariya 7.V—19.VI.

Distribution: Kirgizstan, Turkmenia, Israel. FE: IT.

Sphex (*Prionony x*) *subfuscatus* Dahlb. (syn. *soror* Dahlb.) (?Balthasar 1954)

♂♂♀♀: Jericho 5.IV—22.VIII, Beeri 1.VI, Beerot Yitshaq 25.V, Gvulot 18.V, Kfar Yeroham 3.IV—20.VIII, 22.IX (Fishelson), ?Tabgha 25.VIII (Houška).

Distribution: S. Europe, N. Africa, Israel, Asia Minor. FE: Med.

**Sphex* (*Prionony x*) *crudelis* Smith (syn. *aegyptius* Lep.)

♂♂♀♀: Arnon River 5.VII, Kallirhoe 7.VI, Kfar Yeroham 20.VIII, Bat Yam 5.VII, Pardess Hanna 24.VI, Binyamina 25.IX — 'Ein Harod VI, Hulata 17.VI.

Distribution: India, Madras, East Africa, Egypt, Israel, Syria. FE: Paltrop.

**Sphex* (*Prionony x*) *eatoni* Saund.

♀: Eilat 16.IV (leg. Fishelson).

A mutilated specimen measuring 36 mm and agreeing well with the description given by Saunders (1910).

Distribution: Algiers (Biscra), Egypt, Sinai, Israel. FE: SS.

**Sphex* (*Priononyx*) *stschurovskyi* Rad. ssp. *hyalinipennis* Kohl

♂♂♀♀: Ramat Gan 15.IV—6.V, Gvulot 18.V, Urim 15.V, Binyamina 16.V—2.VI.

The apical infuscation of the fore wing may vary considerably; usually it crosses the whole wing, but in some specimens it reaches from the tip of the radial cell to the tip of the wing in a band not broader than the radial cell itself.

Distribution: (*stschurovskyi* Rad.: Turkestan) ssp. *hyalinipennis* Kohl: N. Africa to Israel. FE: Med.

**Sphex* (*Isodontia*) *splendidulus* Rossi

♂♂♀♀: Qiryat 'Anavim 28.V—22.VI, Ma'ale Hahamisha 28.V—11.VI.

Distribution: S. Europe to Balkans, Israel. FE: Med.

**Sphex* (s. str.) *pruinosus* Germ.

♂♂♀♀: Arnon River Delta 5.VII, Jerusalem 12.V—7.VII, Ramle 24.VI, Bet Naballa VII, Tel Aviv 20—21.V, Bat Yam 5.VII, Rehovot 3.VII, Kfar Yeroham 5.VII, El Tureibe 23.IX (Fishelson), Pardess Hanna 9.IV, Binyamina 25.IX, Tiberias 10.V.

Distribution: Whole Mediterranean, Asia Minor, Caucasus. FE: Med.

**Sphex* (s. str.) *umbrosus* Christ. ssp. *metallicus* Tasch.

♂♂♀♀: Jaffa 13.IX, Miqve Israel 7.VII (Fishelson), Herzliya 12—15.IX, Hadera 8.X, Binyamina 25.IX, Kfar Yeroham 7.VI.

Distribution: Whole Africa to Cape, India, Indomalaya, China, Japan; Arabia, Israel, Iran. FE: Paltrop.

Sphex (s. str.) *maxillosus* Fab. (Balthasar 1954)

♂♂♀♀: Jericho 23.V—25.VI, Jerusalem 1.V—25.VII, VI—VII (Houška), Ramat Gan 14.V.

The population as a whole shows the black markings well developed; there is no ssp. *mavromoustakisi* Beaum. (from Cyprus) with red legs among my material.

Distribution: Central and Southern Europe, N. Africa, Israel to Asia Minor. FE: Med.

Sphex (s. str.) *flavipennis* Fab. (Balthasar 1954)

♂♂♀♀: Jericho 30.IV—7.VII, Wadi Kelt 12.V (Houška), Jerusalem 5.V — 19.VI, Beersheba 22.VI, Kfar Yeroham 5.VII, Binyamina 2.VI, Alonim 17.VI, Rosh Pina 9.V.

One ♀ from Jericho has the thorax entirely red, abdomen normal; several ♀♀ have the propodaeum and legs red to brown (=var. *rufodorsata* Dest.), and a few ♀♀ from Beersheba and Kfar Yeroham have thorax, legs, red-brown and the abdomen entirely red; they occur together with the normal dark form.

Distribution: S. Europe, N. Africa, Israel to Asia Minor. FE: Med.

**Sphex* (s. str.) *afer* Lep. ssp. *sordidus* Dahlb. (syn. *pachysoma* Kohl ?)

♂♂♀♀: Jericho 23—26.V, south end of the Dead Sea, Ramat Gan 6.V, Ascalon 7.VI, Beerot Yitshaq 25.V, Gvulot 22.V, Urim 27.V, Kfar Yeroham 5.VII, Dan (Tel el Kadi) 16.VI.

Distribution: Spain? Israel, Cyprus, Rhodes (type loc.), Syria, Caucasus.
FE: Eastmed.

**Sphex* (s. str.) *melanocnemis* Kohl

♂: New description: body black; the following are red: apical border of 1st abdominal tergite, 2nd tergite (except for a small longitudinal black patch), 3rd tergite (except for a large triangular apical black spot reaching the anterior border of the segment); 2nd and 3rd sternite entirely red, rest of the abdomen black. Wings hyaline, apical border broadly infuscate. Head and thorax covered with erect white hair. A silvery pubescence covers: the clypeus and face, the tegulae and a spot on the mesopleurae, the declining sides of the propodaeum, the dorsal face of the petiolus, and the hind coxae. Tibiae and tarsi also covered with fine silvery hair.

Clypeus elevate, apical edge straight, rounded at the sides. A row of points along the anterior border; surface with reticulate microsculpture and larger points. Frons punctate, dull, except for the sides of the ocellar triangle, which are lucid. Pro- and mesonotum lucid, the first with a few points, the latter with a pointed microsculpture and more dense punctation. Scutellum slightly impressed in the middle, postscutellum almost not, the first with same sculpture as the mesonotum, the latter slightly rugose-punctate, dull. Propodaeum with fine transversal striation. Mesopleurae and mesosternum coarsely punctate; metapleurae punctate above, smooth but dull below. Sides of the propodaeum with very dense pointed microsculpture and a few large points between. *Stigmatic folds absent*!

Abdominal segments lucid, with very fine reticulate microsculpture and scattered points, covered with a fine silky white tomentum.

Antennae very long, reaching back to the tip of the propodaeum. Segments as in Figure 6a. Genitalia as in Figure 6b. Length 15—17 mm.

Neoallotype: 1 ♂ Beersheba 15.V.46. Neoparatypes: ♂♂ Beersheba 15.V, Kfar Yeroham 11.V.

Distribution: Asia Minor, Israel. FE: Eastmed.

It is with some doubt that I attribute this ♂ to Kohl's species, but *S. melanocnemis* Kohl is the only *Sphex* (s.str.) known which lacks the stigmatic folds on the sides of the propodaeum. All other coloristic characters agree well. The less pronounced longitudinal impression on the scutellum and postscutellum may be due to a sexual difference.

SCELIPHRON

Sceliphron (*Chalybion*) *targionii* Car. (Bodenheimer 1937 as *Sc. violaceus* Fab. Balthasar 1954).

♂♂♀♀: Jericho 23.V—20.VII, Wadi Kelt 5.IV, Djiftlik (Wadi Far'a) 19.IV, Ma'ale Haadumim 23.V, Jerusalem—Jericho Road, km 8, 7.VIII, Jerusalem 10—26.VIII, VI—VII (Houška), Kfar Yeroham 1.V—5.VII, Beer Tuvia 3.VI, Tiberias Hot Springs 13.VI, El Hamme 20.IV.

Distribution: Extreme south of Europe, N. Africa, Israel, Syria, Asia Minor, FE: Med.

Sceliphron (*Pelopaeus*) *spirifex* L. (Balthasar 1954)

♂♂♀♀: Jericho 26.IV—16.VIII, Arnon River Delta VIII (Houška), Jerusalem 1—20.VII, VIII (Houška), Ramat Gan 30.V, Binyamina 25—29.V, 'Ein Harod 11.VI, Beit Alpha 7.VII, Tiberias 23.VI, Tabgha VIII (Houška), Dafna 5.VIII. Extremely common and distributed all over the country, also where not recorded in detail.

Distribution: Whole tropical Africa to Cape, Circummediterranean, Asia Minor. FE: Paltrop./Med.

Sceliphron (*Pelopaeus*) *destillatorium* Ill.

♂♂♀♀: Jerusalem 21.V—17.VIII (Tapuchi), 'Ein Harod 7.VI, Deganya 19.IV (ByS), Tiberias 27.V, Migdal 19.V (Gruenberg).

Distribution: Circummediterranean, Asia to Mongolia. FE: Palaearct.

**Sceliphron* (*Pelopaeus*) *tubifex* Latr.

♀♀: Herzliya 25.V (leg. Fishelson), Binyamina 20.VI (ByS), Kfar Gil'adi 7.IX (Gruenberg), rare.

Distribution: Circummediterranean, palaearctic Asia to Japan. FE: Palaearct.

BEMBIX

**Bembix pallida* Radoszk. (Group: *B. integra* Panz.) (Balthasar 1954: ?*B. dubia* Guss.)

♂♂: Environments of Jerusalem 1.VI—10.IX.

Distribution: Balkans, Israel, Asia Minor, Transcaspia, Turkestan. FE: Eastmed/IT.

Bembix palaestinensis* Lohrmann (*Mitt. Muench. Ent. Ges.*, **32, 1942) (Group: *B. hedickei* Giner)

Described after a single ♂ with the locality "Palestine". Dr. de Beaumont, who examined the type from the Zoologische Staatssammlung, Munich, writes to me: "I haven't seen this species in your material (from Israel) and what you thought to be this species is a new species of the *B. gracilis* group. On the other hand, I have already seen several specimens from Tunisia. The species is very close to *B. hedickei* Giner from the Spanish Sahara. Naturally one may ask oneself, whether the locality "Palestine" is not an error."

The species is characterized by the presence of 9 bristles on the anterior metatarsal comb, which no other Israeli species possesses regularly.

Bembix cinctella* Hdl. ssp. **enslini ByS. ssp. nov. (Group: *B. cinctella* Hdl).

♂ (Figure 7c): black, the following are yellow: labrum, clypeus, face (with the exception of 2 triangular black spots above the antennae), a transverse band below the anterior ocellus, broad outer orbits, underside of the scape, and 1st flagellar joint.

An olivaceous band across the base of the pronotum, calli humerali, tegulae and spots directly inside of them, hind borders of the scutellum and postscutellum, spots on the mesopleura and mesosternum and several spots on the sides of the propodaeum. Tergites 1—6 with broad sinuous olivaceous bands, dilate in the middle; tip of the 7th sternite olivaceous. Sternite 1 with the hind border olivaceous, sternite 2 with a broad band including the base of the apophysis; in the middle of this banda transverse black spot. Sternites 3—5 with lateral spots, 6 and 7 black. Legs yellow with the exception of black spots on the inner side of the femora and tibiae; wings hyaline. 15 mm.

♀ (Figure 7d): all light designs yellow, more extended than in the ♂. Besides the parts mentioned in the ♂, the following also are yellow: entire scape and underside of the flagellum, and U shaped mark on the disc of the mesonotum, a rounded band on the disc of the propodaeum, entire pro- and mesopleurae and sternae, and sides of the propodaeum. Bands on tergites 1—5 very broad, on tergites 2—5 including 2 black spots still attached to the anterior black borders. Tergite 6 with large yellow apical spot. Sternites 1—4 entirely yellow, except for narrow black basal borders, sternite 5 with small lateral spots, sternite 6 entirely black. 16 mm.

Holotype: ♂ Jericho, 19—26.IV.34, leg. Enslin (received through the kindness of Dr. de Beaumont). Allotype: ♀ Jericho 26.V.43. Paratype: ♂ Jericho 19—26.IV.34, in coll. de Beaumont.

Distribution: of *cinctella*: Balkans, Greece; of ssp. *enslini:* Israel. FE: Endemic (Eastmed.).

All structural characters and especially the peculiar genitalia of the ♂ agree so well with the description and figures of Handlirsch (1893), that I do not hesitate to include it into *B. cinctella*. The structure of the ♀ also agrees well, but, as it is well known that the distinctive characters of the ♀♀ in the genus *Bembix* are not always sufficiently clear to separate them from nearly related species, I include this ♀ with a small doubt.

Ssp. *enslini* differs from *B. cinctella* Hdl. by its lighter coloration, its larger extension of the yellow areas; the light bands on the abdomen especially are very narrow in *cinctella* and may even be obsolete in the ♂. In its coloration ssp. *enslini* seems to agree well with the nearly related *B. eburnea* Radsz. from Turkestan and Transcaucasia, but it differs clearly in the form of the antennal joints.

Bembix* **holoni ByS. sp. nov. (Group: *B. gracilis* Hdl.)

♂: Black. The following are ivory-yellow (Figure 8a): labrum, except for a brown longitudinal band (not always present), clypeus, broad inner and narrow outer orbits, the first reaching upwards only to the level of the anterior ocelli; a narrow band below the ocelli, antennal scape entirely or with the exception of a black dorsal stripe, underside of the flagellum; legs, except for the inner side of the femora and spots on the inner side of the tibiae; a thin line at the base of the pronotum, calli humerali, tegulae, the scutellar-postscutellar line, and 2 spots on the sides of the propodaeum.

Light designs on the abdomen olivaceous: the band on the 1st tergite narrow, on the 2nd and 3rd laterally dilate, on the 3rd to 5th medially apically constricted; 6th tergite black, sometimes with a small spot, 7th black with yellow tip. 1st sternite with light median line and edges, 2nd to 4th with large apico-lateral spots, the tip of the tooth on sternite 2 also light. Sternites 5—7 black.

Head and thorax densely, abdomen sparingly, covered with light hair. Clypeus and face silvery tomentose.

Head (Figure 8a) broader than long (5:4), clypeus globular, elevate (Figure 8b), anterior margin concave in the middle, finely and densely punctate, interspersed with a few coarse piliferous points; labrum with microreticulation and scattered coarse points. Cheeks narrow; interantennal crest present. Antennae (Figure 8e) long and slender, segments 9 and 10 decidedly convex laterally, 9—12 slightly concave below, 13 curved, rounded at the tip about $1\frac{1}{2}$ as long as the 12th and twice as long as the 11th.

Thorax densely and finely punctate-reticulate. Legs: anterior tarsus symmetrical, the metatarsus usually with 8, sometimes with 9 bristles (in the latter case the basal bristle is doubled). Edge of the median femur (Figure 8c) finely serrate with only a few teeth, metatarsus broadened, spinulose (Figure 8d). Wings hyaline, forewing about twice as long as the thorax, hindwing with one vein from the medial cell.

Abdominal tergites strongly and evenly punctate, the 7th very coarsely punctate towards the tip. Sternites (Figure 8f) strongly punctate, the 1st with a low basal median crest, the 2nd depressed at its base with a high median crest terminating in an acute tooth, the 6th with a low median tubercle showing coarser punctation, the 7th (Figure 8g) elongate trilobate at its tip, smooth in the middle, and finely punctate at the sides. Genitalia as in Figure 8h. 14—16 mm.

♀ (Figure 7a): coloration similar to the ♂ but the light designs more extended. The clypeus has often 2 black basal spots. Prothorax extensively ivory, mesothorax ivory at the sides, light bands also on the edge of the scutellum and postscutellum and on the disc of the propodaeum. Light bands on the abdominal tergites broader than in the ♂. Tip of the 6th tergite light. 1st sternite with 2 lateral black spots, in the 2nd and 3rd the light bands not interrupted, the 4th and 5th with 2 lateral light spots. Tip of sternite 6 light. Pilosity and toment as in the ♂.

Head broader than long (5 : 3.5); clypeus globular, basolaterally depressed, anterior border slightly concave; mandibles with one lateral tooth. Punctation of the body as in the ♂. 5th and 6th tergite spinulose at the sides, tip of the 6th rounded. 6th sternite with very few large points. Anterior tarsus (Figure 8i) slightly asymmetrical, pecten of the metatarsus usually with 8, rarely with 9 bristles. 14—16 mm.

Holotype and allotype: ♂♀ Holon 3.V.45. Paratypes: Holon 3.V, Bat Yam 20.IV—10.VI. Named after the town of Holon, 6 km SE of Tel Aviv, built in the midst of the dunes ("Hol" in Hebrew means "sand"). The species is ecologically a typical sand dune form.

The occasional occurrence of 9 pectinal bristles induced me to identify this new species with *B. palaestinensis* Lohrm. But according to its ♂ genitalia it belongs to the *B. gracilis* group. It differs from the description of *B. gracilis* Hdl. from the Caucasus and Transcaspia by its globular clypeus, antennal joints 9 and 10 more convex in the ♂, genital valvae shorter and broader. In coloration *B. gracilis* has more extensive light designs, e.g. 2 streaks on the disc of the mesonotum, isolated spots on tergite 2, and the sternites 1—4 entirely yellow.

Bembix* **joëli ByS. sp. nov. (Group: *B. gracilis* Hdl.).

♂ (Figure 7b): black, the light designs lemon yellow (not ivory and olivaceous as in *B. holoni*). The following are yellow (Figure 9a): clypeus, labrum, face (except for 2 connected longitudinal spots above the antennae and a cross bar on the occiput): entire pronotum and humeral calli, an elongate spot inside the tegulae and these last also; bands on the scutellum, postscutellum, propodaeum and its posterior angle. Abdominal tergites with broad uninterrupted yellow bands, the apical borders on segment 1 and 2 straight, on segments 3—5 constricted; on segments 2—5 basally constricted by large discal spots which are confluent with the narrow basal bands. Apical half of the 7th tergite yellow. Sternites 1—4 completely yellow or with small lateral black spots,

5—6 with broad slightly restricted yellow bands; 7th sternite black. Clypeus and face with silvery tomentum.

Head broader than long (5 : 4) (Figure 9a). Clypeus elevate (Figure 9b), less globular than in *B. holoni*, anterior border straight in the middle. Cheeks broader than in *B. holoni;* antennae (Figure 9e) shorter and thicker than in *B. holoni*, all segments except the 3rd shorter, 7—10 laterally convex, 10—13 concave below.

Thorax punctate, the points isolate and larger than in *B. holoni*. Outer side of the anterior tibia with 6—7 strong spines (4—5 in *B. holoni)*; anterior metatarsus with a comb of 8 bristles, the basal one however very short. Midfemora strongly spinose (Figure 9c), tibia with a row of spines, metatarsus cylindrical (Figure 9d). Wings hyaline, twice as long as the thorax.

Abdominal tergites with large and well separated points, those on the apical borders smaller. 7th tergite rounded at the apex, its base densely punctate, its apical half lucid with scattered large points. Punctation of the sternites less dense, the points larger. Median crest of the apophysis of the 2nd sternite (Figure 9f) shorter, the tip higher and more rounded than in *B. holoni*. Tubercle on sternite 6 high, triangular, with acute edges and pointed tip. 7th sternite with 3 distinct carenae (Figure 9g), tip broad, bilobed. Genitalia (Figure 9h) with the valves more elongate than in *B. holoni*. 16—17 mm.

♀: Coloration similar to the ♂, but black designs on the head extended; 2 black spots at the base of the clypeus, the two bands above the antennae broader, reaching the inner orbits above, the whole ocellar region and the occiput black. Thorax and abdomen as in the ♂ except: a broad yellow median band on tergite 6; sternites 3—5 with black basomedial spots, that in sternite 5 bordering the whole apical part of the segment and almost reaching the hind border; 6th sternite black with yellow tip. Face and clypeus with silky toment.

Head broader than long (5:4); clypeus basolaterally depressed, edge straight in the middle. Punctation of the body as in the ♂ except for the sternites, which show a very fine micropunctation interspersed with a few very large points; this micropunctation is finer than in *B. holoni* ♀, where it is more reticulate. Apical borders of tergite 5 spinulose, as well as the sides of the 6th tergite.

Anterior tibiae (Figure 9i) with 5—7 strong spines, metatarsal comb consisting of 8 bristles, the basal one very short. 15—17 mm.

Holotype and allotype: ♂♀ Kfar Yeroham 24.VI. Paratypes: Kfar Yeroham 1—24.VI, Revivim 11.V. *B. joëli* seems to be confined to the wadis of the Negev.

The main differences between *B. holoni* (and *B. gracilis*) and *B. joëli* lie in the coloration, the structures of the clypeus, cheeks, tibiae, tarsi in the ♂ and ♀, the 2nd and 6th sternites and the genitalia in the ♂.

**Bembix kohli* Mor. (Group: *B. megerlei* Dahlb.)

♂♂♀♀: Bat Yam 11.VI—28.VII, Holon 9.VII, Ramat Gan 12.VI, Halutsa 1.VI. These specimens agree perfectly with the description given by Morice (1897).

Distribution: Egypt, Israel. FE: SS.

**Bembix bicolor* Radoszk. (Group: *B. sinuata* Latr.)

♂♂♀♀: Arnon River Delta 5.VII, Jericho 26.V—16.VII, Jerusalem 16.VI, Haluza 3.VI, Kfar Yeroham 5.VII.

The coloration is very variable, the dark designs tending to orange yellow and being much reduced in the ♀♀, where the discal spots on abdominal tergite 1—3 are small and always well separated from the apical bands (= ab. *femoralis* Radz.). The ♀ from Arnon River has 2 broad stripes on the disc of the mesonotum; scutellum, postscutellum and propodaeum (except for basal border), entirely yellow, and the light brown and small discal spots distinct only on tergite 1; on tergite 2 and 3 only indicated as diffuse clouds. Dark apical borders very narrow, tending to brown.

Distribution: Israel, Cyprus, Asia Minor, Turkestan to Mongolia. FE: IT.

Bembix dahlbomi Hdl. and *ssp. **sabulosa** ByS. ssp. nov. (Group: *B. admirabilis* Rad.)

The typical (Figure 7e) light and strongly variegated *B. dahlbomi* Hdl. occurs on the light sandy loess soils in the Negev. ♀♀: Urim 20.XI, Revivim 3—15.VIII.

In the coastal dunes near Tel Aviv occurs another form with much extended black designs: ssp. *sabulosa* ssp. nov.

In the ♂ (Figure 7f) the disc of the mesonotum completely black, in the ♀ (Figure 7g) with very thin partly interrupted U shaped stripe. Disc of the propodaeum entirely (♂) or almost entirely (♀) black. Mesopleurae and sterna entirely black (♂) or heavily variegated with black (♀). Abdominal tergites 1—5 with broad black basal and apical borders, the discal spots broadly attached to the basal bands. In the ♂ holotype the yellow bands on most segments interrupted, in the paratypes constricted only. 6th (♀) or 7th (♂) tergite entirely black. Sternites 1—4 with much extended black designs, 5th (♀) and 6th (♂) entirely, 6th (♀) and 7th (♂) almost black.

Holotype and allotype: ♂♀ Bat Yam 5.VII.48. Paratypes: ♂♂♀♀ Bat Yam 10.VI, Holon 28.X.45.

Distribution: N. Africa, Israel. FE: SS (the subspecies: Endemic).

Bembix olivacea Fab. ssp. (Group: *B. olivacea* F.) (syn. *B. mediterranea* Hdl.)

♂♂♀♀: Bat Yam 3.VI—5.VII, Herzliya 17.VI, Haifa, sandflats near Kishon River 28.VII.

The Israeli race is characterized by the reduction of light designs; disc of the mesothorax entirely black, black markings on the abdomen reduced, apical bands narrow, the discal spots on tergite 2 small, free standing. The species *B. olivacea* comprises several valid subspecies, the synonymy of which, however, is not cleared up. The ssp. from Israel is not ssp. *saharae* Gin.-Mar. from Morocco, which occurs also in Egypt and to which I attribute some specimens from the Salt Lake near Karapinar, Anatolia, 6.VIII, leg. ByS, with very rich U-shaped yellow designs on the disc of the mesothorax. The Israeli specimens may be perhaps ssp. *mediterranea* Hdl., but Handlirsch (1893) gives no type locality for his species.

Distribution (of the species *olivacea* Fab.): Whole Mediterranean region, Hungary, S. Russia, Caucasus, Amur. FE: Med./Penetr. Eurosiber.

**Bembix arenaria* Hdl. (Group: *B. olivacea* F.) (syn: *B. houškai* Balth. 1954)

♂♂♀♀: Bat Yam 19—21.V, Holon 28.X, Tel Aviv 1.IX—25.X, Ramat Gan 9—12.VI, Ramat Gan ('Esser Tahanot) (Houška), Ramat Hasharon 19.VII, Herzliya 17.VI, Ra'anana 5—13.VII, Haifa, Bat Galim 27.VII, Haifa, sandflats near Kishon River 28.VII, Nahariya 11.VI, Ma'oz 1.XI, Qiryat Shmone 21.VI. I do not know this species from the lower Jordan valley, and what Balthasar (1954) quotes from the "Tal

des Jordan" may be perhaps another species. In Figure 7h the coloration of a ♂ from the coastal zone is given for comparison with the figure of the abdomen of *B. houškai* given by Balthasar (1954).

Distribution: Israel, Syria. FE: Eastmed.

Bembix oculata Latr. (Group: *B. oculata* Latr.) (Balthasar 1954)

♂♂♀♀: Arnon River Delta 5. VII, Jericho 15. XI, Wadi Kelt VII, XI (Houška), Jerusalem 12.VII—28.VIII, Bnei Braq 28.VI, Ramat Gan 3.V—5.VI, Giv'at Brenner 19.VII, Ascalon 15.X, Tiberias 3.X, Deganya 3.IX, Amir 16.VIII.

The Israeli specimens of this coloristically very variable species combine characters of the Syrian f. *basalis* Dahlb. and the Egyptian f. *soror* Dahlb. In all of them the wings are fumigated and the discal spots on the 2nd and 3rd abdominal tergites usually separate as in f. *basalis*, but the yellow designs on the thorax usually well developed as in f. *soror*: mesothorax edged with yellow on its sides and behind, disc very often with a distinct U-shaped mark, mesopleurae with large yellow spots, propodaeum with the usual yellow markings enlarged. Labrum either light, or with dark basal spot, or with dark longitudinal band.

The only ♂ from Upper Galilee differs by its dark brown clypeus, its almost black thorax, dark wings and extended black bands on the abdomen, which are broadly connected with the discal spots. The specimen is similar to those from Turkey and should probably be attributed to the f. *fuscilabris* Mocs. from the Balkans.

Distribution: in several not well differentiated forms around the whole Mediterranean, north to Hungary, east to the Caucasus, Asia Minor, Turkmenia, Iran. FE: Med.

Bembix turca* Dahlb. ssp. **picturata ByS. ssp. nov. (Group: *B. oculata* Latr.)

The typical form, which has been described from Rhodes, has the abdomen entirely black ("Abdomen nigrum immaculatum", Dahlb., *Hym. Europ. Bor.*, 1843—45, p. 488). In Israel occurs a form which structurally belongs to *B. turca*, but which differs by its rich yellow designs on the abdomen = ssp. *picturata* ssp. nov.

♂: Colour black; the following are greenish yellow: clypeus, labrum, a broad line along the inner orbits, and a narrow one along the outer ones, antennal sockets and a small spot between them, underside of the scape, a narrow transverse line on the base of the pronotum, the distal part of the humeral calli and tegulae. Rest of the thorax black or with a transversal line on the scutellum.

Abdominal tergites 1—4 with wide uninterrupted yellow bands, that on the 5th slightly interrupted in the middle. Black basal border of the 1st tergite triangular dilate, the 2nd with rectangular spots on the disc broadly connected with the anterior black band, in the other segments the basal bands almost straight. Posterior black bands rather broad; 7th tergite black with 2 small apical spots. Sternites black with small triangular yellow spots on segments 1—5.

Legs yellow: black are coxae, trochantera, more than the basal half of the femera and spots on both sides of the anterior tibiae. 14—16 mm.

♀: (Fig. 7 i) similar in coloration to the ♂ but the lateral angles of the propodaeum also yellow. Abdominal tergites 2—5 with large discal spots broadly connected with the anterior bands: in all segments a median longitudinal line, indicated

only in the anterior segments but dividing the yellow band entirely in segment 5, sometimes already in segment 4. 14—17 mm.

Holotype and allotype: ♂♀ Bat Yam 5.VII. Paratypes: ♂♂♀♀ Bat Yam 5.VII, 27.VII, 24.X, Tel Aviv 12.VIII, Binyamina 4.XII, Nahariya 11.VI. The subspecies seems to be confined to the coastal zone of Israel.

Distribution: *turca* s. str.: S. Balkans, Rhodes, Israel, S. Russia. FE: Eastmed.

B. turca Dhlb. ssp. *picturata* greatly resembles in coloration *B. bolivari* Merc., which however is regarded by de Beaumont (1949) as also only a geographical race of *B. turca*. It differs by the more dense punctation of the abdominal tergites in the latter, by the much more elevated crest on the 2nd sternite which terminates in a strong tooth in ssp. *bolivari*, while the crest is much less developed and the tooth almost nonexistent in ssp. *picturata*. The punctation of the 3rd to 5th sternites is much denser in ssp. *bolivari* than in ssp. *picturata*, where, especially in the ♂, the discs of these sternites are almost devoid of points.

**Bembix radoszkowskyi* Hdl. (Group: *B. oculata* Latr.)

♂♂♀♀: Halutsa 3.VI, Revivim 11.V, Kfar Yeroham 5.VII—20.VIII.

Distribution: N. Africa, Sudan, Obok, Israel. FE: SS.

The prevalent colour of the ♂ is pictured in Figure 7k.

BEMBECINUS

Bembecinus tridens F. [?Balthasar 1954: Wadi Kelt VI—VII (Houška)]

♂♂♀♀: Ramat Gan 4—14.IV, Bnei Braq 7.IV, Pardess Hanna 14.VII, Haifa, sandflats on the Kishon River 28.VII, Nahariya 12.VII, Rosh Haniqra 9.VII, Tiberias 12.VII, 'Ein Gev 23.IV, El Hamma 18.IV, Amir 16.VII, Nir 'Am 5.IX, Ruhama 27.VI, Beersheba 3—23.VI, Kfar Yeroham 5.VII—20.VIII.

According to my material (40 specimens) the species does not seem to occur in the Judean Hills and the lower Jordan valley.

Distribution: Europe, N. Africa (excl. Egypt), Israel, Asia Minor to C. Asia. FE: Palaearct.

Bembecinus bytinskii* de Beaum. (1954, Mitt. schweiz. Ent. Ges., **27)

♂♂♀♀ : Jericho 26.V—22.VIII, Jerusalem 18.IX, Nahariya 11.VI (Types), Deganya (Palmoni),Bnei Braq 7.VI.

Distribution: Israel. FE: Endemic (Eastmed.?)

**Bembecinus revindicatus* Schulz (syn: *B. houškai* Balthasar 1954)

♂♂♀♀: Jerusalem 24.IV—20.VI, Jerusalem 8—18.V (Houška).

Distribution: Syria (Type from Damascus), Israel. FE: Eastmed.

**Bembecinus meridionalis* Costa

♂♂♀♀: Wadi Kelt 5.IV, Wadi 'Auja 17.IV, Jerusalem 21.V—12.VII, Ma'ale Hahamisha 28.V, Binyamina 15.V—2.VI, Nahariya 7.V, Ayelet Hashahar 16.V.

Distribution: Italy, Balkans, Syria, Israel. FE: Eastmed.

**Bembecinus peregrinus* Smith

♂♂♀♀: Tiberias 7.IV (Palmoni), 'Ein Gev 4—5.IV.

Distribution: S. Italy, Balkans, Syria, Israel. FE: Eastmed.

Bembecinus cyanescens Rad. (Bodenheimer 1937)

This record may refer to any of the 5 above mentioned species, probably however to *B. tridens* F. Probably a misidentification.

Distribution: Turkmenia. FE: IT.

**Bembecinus gynandromorphus* Handl. (Balthasar 1954)

♂♂♀♀: Jerusalem 1.V, 11.V (Houška), Binyamina 29.V, Zikhron Ya'aqov 5.V.

Distribution: Israel, Syria. FE: Eastmed.

STIZOIDES

Stizoides* **verhoeffi ByS. spec. nov.

A large species, completely black, the wings also entirely black, slightly bluish iridescent. Structurally very near to *S. klugi* Sm.

♀: POL : OOL = 2:1. Antennae: 3—5th joint = 36:20:18. Anterior tarsus (Figure 10a) with the external lobes very pronounced, pecten on the metatarsus consisting of 6 bristles, of these 2 apical ones on the lobe and 4 more or less equidistant on the side (*klugi* : 5=2+3). Abdominal sternites, especially the first, much more strongly punctate than in *klugi*. 6th tergite (Figure 10b) slightly spinulose at the base, the sternite (Figure 10c) distinctly notched (in *klugi* both straight). 20—23 mm.

♂ : POL : OOL = 2:1. Antennal joint 3:4:5 = 35:19:18. Pecten of the anterior metatarsus as in the ♀, with 6 bristles, 2 apical and 4 lateral ones.

Punctation of the abdominal tergites fine and dense, the punctation on tergites 3—5 finer than on tergites 1—2, becoming coarser and less dense towards the posterior parts on tergites 3—5 (in *klugi* the punctation is even finer and more dense, but already tergite 2 is more finely punctate than tergite 1, and the punctation on each tergite almost uniform). 7th tergite triangular, rounded, slightly notched at the apex (in *klugi* rounded). Abdominal sternites coarsely punctate, the 7th rounded at its apex. Sternal crest of the 1st sternite elevated, terminating into a large tooth as in *klugi*. Genitalia as in *klugi*. 19—21 mm.

Holotype and allotype: ♀♂ Urim 15.V.46. Paratypes: ♂♂♀♀ Urim 12 — 15.V, Revivim 11.V, Kfar Yeroham 1.V, on flowers of *Haplophyllum tuberculatum*.

Distribution: Israel (Negev). FE: Endemic (Saharo-Sindic).

The affinity of *S. verhoeffi* to *S. klugi* is very close. The sculpture and proportions of the different parts of the head, the thorax, the proportions of the legs, the form of the crested apophysis on the 1st sternite and the ♂ genitalia, agree with this species, as well as the antennal joints and POL : OOL and the flattened metatarsus with a longitudinal grove in the ♀.

The major differences between *S. verhoeffi* and *S. klugi* are again:

Size: ♂ 19 — 21 mm, ♀ 20 — 23 mm (Negev population: ♂ 13—15 mm, ♀ 15—17 mm).

Colour: entirely black (antennae, legs and last body segments red brown, rarely entirely black).

Pecten of the anterior metatarsus: with 6 bristles (5 bristles)

Tip of the 6th abdominal tergite and sternite in the ♀ and of the 7th tergite in the ♂: notched (rounded).

Period of occurrence: beginning of V (end VI—VII).

Both species occur at the same locality (Kfar Yeroham).

In the field, the appearance and habits of this species resemble strongly those of *Stizus fuliginosus* Klug. Both species belong to the strongest and swiftest flyers among the Sphegids.

**Stizoides klugi* Smith

♂♂♀♀: Kfar Yeroham 24.VI—5.VII on flowers of *Polygonum equisetifolium*.

The specimens have the normal coloration: antennae, legs and abdominal segments 4—6 ferruginous, but the population is of rather small size: ♂♂ 13—15 mm, ♀♀ 15—17 mm. Mocchi (1939) gives 11—19 mm, Handlirsch (1891) even 21 mm.

The coloration of *S. klugi* is very variable (Schulz 1906). Morice (1911) mentions almost black specimens from Biskra, and Mocchi (1939) speaks of entirely black specimens. Dr. de Beaumont also informs me that he has completely black specimens from Biskra. It is possible that some of these black specimens belong to the former species.

Distribution: N. Africa to Egypt, Israel. FE: Saharo-Sindic.

**Stizoides poecilopterus* Hdl. (Balthasar 1954)

♂♂♀♀: Jericho 10.VI—20.VII, Wadi Kelt 12.VII (Houška).

Distribution: Ethiopia, Sudan, Egypt, Israel. FE: Ethiop.

**Stizoides melanopterus* Dahlb. (Balthasar 1954)

♂♂♀: Jericho, Wadi Kelt 25.VI (Houška), Binyamina 7.V, Kfar Blum 15.V, Kfar Yeroham 23.V.

All specimens have orange bands on the 2nd and 3rd abdominal tergite, one ♂ also traces of a band on the 4th tergite.

Distribution: Egypt? (Savigny Tab. 16 fig. 24) Israel, Rhodes, Asia Minor, S. Russia. FE: Eastmed.

**Stizoides tridentatus* Fab.

♀♀: Environments of Jerusalem 11—15.VI, Revivim 12.V, Kfar Yeroham 5.VII.

Distribution: S. Europe, N. Africa, Israel, Cyprus, Asia Minor to Turkestan. FE: Med./IT.?

Stizoides crassicornis Fab. (Balthasar 1954)

♂♀: Jericho 13.IV, Wadi Kelt 6.VI (Houška), Kfar Yeroham 5.VII, Gvulot 18.V.

Distribution: S. Europe, S. Russia to Turkmenia, N. Africa, Egypt? Israel, Cyprus. FE: Med.

STIZUS

Stizus fasciatus Fab. (Group: *S. fasciatus* F.)

Binyamina 7—29.V. A colony of over 100 nests; the ♀♀ carry full grown nymphs of *Calliptamus*. The coloration of the ♂ is given in Figure 11b.

Distribution: Whole Mediterranean region (excl. Egypt), Asia Minor. FE: Med.

**Stizus hebraeus* Balt. (Group: *S. fasciatus* F.) (Balthasar 1954)

Chromatically similar to *S. fasciatus* F., but differing by its richer yellow designs.

♂: New description (Figure 11a): body colour black. The following are yellow: mandibles except for the tip, clypeus and labrum, face except for 2 black points at the upper border of the clypeus (in *S. fasciatus* the face is black), broad inner and more narrow outer orbits. A broad band on the pronotum including the humeral

calli, sides of the mesonotum, and tegulae. A broad band on the scutellum and a more narrow one on the postscutellum. Propodaeum with a V shaped band and broad lateral spots. A small spot on the propleurae and a larger on the mesopleura (in *S. fasciatus* all these regions, except the tegulae and a small spot above, are black).

Abdominal tergites with uninterrupted yellow bands constricted in the middle (in *S. fasciatus* the bands, at least on tergites 1—4, are broadly interrupted). 7th tergite yellow except for black base and tip (in *S. fasciatus* black with 2 lateral yellow spots). Sternite 1 black, the others yellow with dark longitudinal bands (in *S. fasciatus* all tergites black with small lateral spots).

Scape of the antenna yellow, flagellum orange, infuscate above. Legs yellow except for bases of fore, middle, and basal half of hind femora, which are black. Wings hyaline (in *fasciatus* yellow brown) with the radial cell infuscate. 17 mm.

In its structural characters *S. hebraeus* Balt. is also similar to *S. fasciatus* and I am noting only the differences:

Head slightly broader (33:40 against 40:50 in *S. fasciatus*). 7th tergite more rounded at the tip, sides almost straight (in *S. fasciatus* slightly incavate); carena on the base of the 1st abdominal sternite (between the hind coxae) rounded above (in *S. fasciatus* longer with a distinct elevated crest). Sternites finely, not very densely, punctate, therefore lucid (in *S. fasciatus* more densely punctate and therefore opaque), intermixed with many larger bristle bearing points (which are almost lacking in *S. fasciatus*, where most of the fine points bear bristles). 8th sternite (Figure 12a) broader, the teeth shorter and the accessory teeth at the base almost lacking (in *S. fasciatus* (Figure 12c) well developed). The differences in the genitalia between *S. hebraeus* and *S. fasciatus* are shown in Figure 12b, d).

Neoallotype: ♂ environments of Jerusalem (Dir Yasin) 7.VIII.46. Neoparatype: 5 km NE of Nahariya 11.VI.

♀: In coloration exactly as the ♂ but antennae not infuscate above. Differs structurally from *S. fasciatus*: 2nd and 3rd anterior tarsal joint more asymmetrical, protruding externally. Mesonotum more lucid, punctation less dense; 7th tergite more slender, less densely punctate, with fewer but longer bristles. Apophysis of the 1st abdominal sternite rounded as in the ♂. Surface of the other sternites lucid, finely punctate, intermixed with coarse points (in *S. fasciatus* ♀ dull, finely reticulate, intermixed with small points. 15 mm (holotype) — 17 mm.

♀♀: Wadi Kelt 22.VII (Houška) (holotype), Jerusalem 24.VI, Rosh Pina 21.VII (leg. Verechson).

Distribution: Israel (hills and mountains). FE: Endemic (Eastmed.).

S. hebraeus Balt. can be easily be distinguished from *S. fasciatus* in both sexes by the yellow colour of the underside of the abdomen, the rounded apophysis of the 1st sternite, the punctation of the other sternites, in the ♂ by the different shape of the 8th sternite and the genitalia, and in the ♀ by its different anterior tarsus. Balthasar (1954) has already pointed out the close relationship with *S. pygidialis* Hdl., described after 1 ♀ from Rhodes, but as long as the ♂ of this species is not known, I agree to consider it for the moment as a distinct species.

**Stizus hyalinipennis* Handl. (Group *S. fasciatus* F.) (Balthasar 1954)

♀♀: Wadi Kelt, Arnon River Delta 21.VI—17.VIII (leg. Houška).

I have not seen this species; its occurrence is very likely, but the specimens may also belong to the following species.

Distribution: N. Africa, Sinai (type locality), Israel. FE: SS.

**Stizus jordanicus* Lohrm. (Group: *S. fasciatus* F.)

I have only 1 ♀ from Wadi Kelt 5.IV, and therefore cannot add anything to Lohrmann's (1942) description. The ♂ is still unknown.

Distribution: Lower Jordan valley. FE: Endemic (SS.)

**Stizus savignyi* Spin. (Group *S. fasciatus* F.) (syn. *succineus* Klug).

♀♀: Kallia 18.VII, south end of Dead Sea (Sdom) 16.VIII.

Coloration: head and thorax red brown, mesothorax with dark thin median and lateral lines. Basal borders of abdominal tergites 1—3 brown, disc yellow; tergites 4—7 entirely brown.

Distribution: Sudan, Egypt, Israel. FE: Ethiop.

Stizus vespoides Walk. (Group: *S. fasciatus* F.) (Balthasar 1954)

♂♂♀♀: Wadi Fukra 14.VIII, south end of Dead Sea (Sdom) 16.VIII, Arnon River Delta 7.VI (ByS. and Houška), Jericho 11.VI—2.IX, Wadi Kelt 21.VI (Houška), Rishon le Zion 29.VII (leg. Ginzburg), Herzliya 28.VIII, Binyamina 15.VII. Though the species is common in the Dead Sea region, it is also found rarely in the coastal plain on light (but not dune) soil.

The disc of the 1st abdominal tergite varies from brown to entirely yellow.

Distribution: Sudan, Egypt, Israel. FE: Ethiop.

**Stizus marthae* Handl. (Group: *S. fasciatus* F.)

♂♂♀♀: Jericho 11—25.VI, south end of Dead Sea (Sdom, 'Ein Bedda) 14—16.VIII, Wadi Fukra 12.VI, Revivim 12.V, Kfar Yeroham 24.VI.

This species occurs in Israel in 2 colour forms, a light one which comes very near to *S. marthae* Hdl. from Biskra, and a dark one which corresponds well to *S. cheops* Mor. from Egypt. De Beaumont (1950) has already pointed out that both species are conspecific, but what Mocchi (1939) described and figured as *S. marthae* Hdl. is another species, perhaps *S. lepidus* Klug. On the other hand his *S. cheops* Mor. "forma chiara" corresponds to *S. marthae*. I give here again a coloristic description of the two forms according to specimens from Israel.

Light form (corresponding to *S. marthae* Hdl.) (Figure 11c): head yellow, only a black transversal band on the occiput, which may extend ventrally to include the anterior ocelli and may even extend to the base of the antennae. Thorax black; the following are yellow: pronotum, sides of the mesotonum, humeral calli, tegulae, and 2 longitudinal triangular spots on the disc beside the mid-line; scutellum, postscutellum, propodaeum with the exception of its anterior edge and 2 oblique lines converging from the antero-lateral angles to the hind tip; a large patch on the mesopleurae. Abdominal tergites yellow, the first sometimes with ferruginous base or 2 small reddish spots on the disc; apical borders of all tergites black. Sternites almost completely yellow, with traces of darker apical bands and a longitudinal line. Antennae: scape and last segments yellow, the rest red brown; segments 7—11 infuscate. Legs red brown.

Dark form (corresponding to forma *cheops* Mor.) (Figure 11d): head as in *S. marthae* but the whole occiput may be dark. Pronotum narrowly yellow, mesonotum black, yellow only at the sides, disc completely black or with traces of the longitudinal bands. Scutellum yellow, postscutellum either completely black or with a thin transverse yellow band; propodaeum either completely black or with a thin similar band. All dark designs on the abdominal tergites black (not partially ferruginous); basal bands broad, extended in the midline to meet the broad apical bands on tergites 1—3, which are triangular in the middle. 1st sternite black, 2nd ferruginous, the apical third black; the 3rd black with large basolateral spots, the other sternites black with small yellow lateral spots or a thin apical border. Antennae and legs as in f. *marthae*.

Numerous transitions exist between these two forms, but f. *cheops* has so far been found only at Kfar Yeroham, where it occurs together with f. *marthae*.

Distribution: N. Africa, Israel. FE: SS.

**Stizus tricolor* Hdl. (Group: *S. fasciatus* F.)

♂♂♀: South end of the Dead Sea (Sdom, leg. Theodor), Kallirhoe 7.VI, Haifa 28.VII, Hula 23.VI (leg. Wahrman, det. and in coll. Verhoeff).

Distribution: Israel, Syria, Cyprus. FE: Eastmed.

**Stizus niloticus* Hdl. (Group: *S. fasciatus* F.)

♂♂: Jericho 11.VI—30.X, Revivim 15.VI.

Most specimens have the mesonotum black, rarely ferruginous; all have the first 2 tergites red brown, sometimes with black more or less broad borders; usually the 3rd segment has a red brown border somewhat dilate in the middle. The 8th sternite and the genitalia agree well with those pictured by Mocchi (1939, Pl. 8, fig. 100, 101), but unfortunately no ♀ is available to differentiate this species from *S. arnoldi* Mocchi. *S. niloticus* Hdl. somewhat resembles *S. ferrugineus* Sm., but can immediately be distinguished by the carinate base of the 1st sternite.

Distribution: Egypt, Sinai, Israel. FE: SS.

**Stizus anchorites* Turn. (Group: *S. fasciatus* F.)

1 ♂: Jericho 7.VII.

This specimen differs somewhat in coloration from Egyptian specimens as figured by Mocchi (1939 pl. 2 fig. 11), but the 8th sternite and the genitalia agree with Mocchi's drawings (pl. 8 fig. 102, 103).

Coloration: clypeus and face yellow, thorax black, but pronotum, humeral calli, tegulae, sides of the mesonotum, scutellum, propodaeum (with the exception of a black basal line), red brown. Abdominal tergites 1 and 2 red brown, the 1st with narrow, the 2nd with broad, blackish brown apical band. Segments 3 and 4 yellow (in Egyptian specimens only tergite 3 yellow), with apical borders dark, somewhat dilate in the middle. Tergites 5—7 blackish brown, tergite 5 with 2 small lateral yellow spots; tip of 7th tergite red brown. All sternites dark brown, sternite 1 red brown at its base only. Legs red brown, with the underside of the femora darkened.

Distribution: Egypt, Israel. FE: SS.

Stizus ruficornis* Fab. ssp. **eremicus ByS. ssp. nov. [Group: *S. ruficornis* F. (Balthasár 1954 as *S. ruficornis* F.)]

♂♀: (Figure 11f): all light designs of thorax and abdomen extended and orange brown. Only the following remain yellow: the labrum, clypeus and face, the border of the pronotum and the humeral calli. The following are orange brown: the antennae, lateral bands on the mesonotum towards the tegulae, tegulae, scutellum and the border of the postscutellum; all abdominal tergites, of which the 1st—3rd have black hind borders and a median black band. Black designs of the abdominal sternites very variable, in some as in typical *S. ruficornis* F., in others reduced to a fine longitudinal stripe as in *S. distinguendus* Hdl. (sensu Berland 1925). Antennae and legs, except coxae, orange brown.

Holotype ♂ and allotype ♀: Beersheba 18.V. Paratypes ♂♂♀♀: Wadi Kelt 5.IV, Jerusalem 15—30.V, Kfar Yeroham 1.V—5.VII. Also: Jerusalem 22.V (Houška).

This new subspecies agrees well in its morphological characters (antennal segments, genitalia etc.) with *S. ruficornis* but differs in its coloration (Figure 11e): in *S. ruficornis* Fab. all light designs are yellow and the black bands on the abdomen much extended.

Distribution: Israel. FE: Endemic (SS?)

**Stizus pubescens* Klug (Group: *S. ruficornis* F.)

♂♂♀♀: Old Jericho Road 9.VI, Jerusalem 15.V — 12.VII, Bror Hayil 1.VI, Beerot Yitshaq 25.V, Beersheba 18.V, Kfar Yeroham 1.VI—5.VII.

All specimens have the scutellum yellow; otherwise there is a great deal of chromatic variation: a few specimens have all designs black and yellow; usually part of the designs of the 1st and 2nd tergite are changed to red brown. In the ♀ from Old Jericho Road all black designs are red brown (the middle of the mesothorax slightly darker) and the 1st abdominal segment entirely red brown. Similar specimens occur also in Cyprus. The black middle line is usually present, but sometimes changed to red brown.

Distribution: Spain, N. Africa, Israel, Cyprus. FE: Med./SS.

**Stizus ferrugineus* Smith (Group: *S. ruficornis* F.) (Balthasar 1954)

♂♂: Wadi Kelt 17.VI—1.VIII (Houška), Jericho 2.VI — 9.VII, Revivim 11.V, Kfar Yeroham 1.VI—5.VII.

The quotation of *S. biclipeatus* Christ (Bengal, Himalaya) in Bodenheimer (1937) may perhaps refer to this species.

The lightest specimens have only the disc of the 1st abdominal tergite and a spot on the 2nd tergite red brown, the rest is yellow, with the apical borders of the segments dark brown. Others have the first two tergites entirely red brown, their apical borders and the 3rd segment partially black. This form is transitory to f. *kohli* Mocs., with the 3rd segment entirely black, which form is also well represented in my material.

Distribution: tropical Africa from Cape to Egypt, Israel. FE: Ethiop.

**Stizus fuliginosus* Klug (Group: *S. ruficornis* F.)

♂♂♀♀: Bat Yam 11.VI—5.VII, Gvulot 22.V, Kfar Yeroham 1.VI.

The Israeli specimens differ from those of Egypt and Arabia in being practically black and so approximate the coloration of *S. spinulosus* Rad. Only the orbits, frons and tarsi are very dark black brown. The morphological characters, however, agree perfectly with *S. fuliginosus* as described by Handlirsch (1892) and Mochi (1939).

Distribution; West Africa, Arabia felix, Egypt, Israel. FE: Aeth./SS.

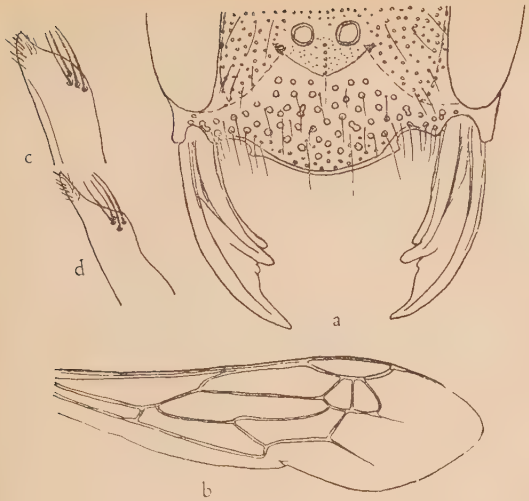


Figure 1

Ammophila maris-mortui ByS. spec. nov. a—clypeus ♀; b—forewing ♀; c—valva ♂; d—*Ammophila hirsuta mervensis* Rad. valva ♂.

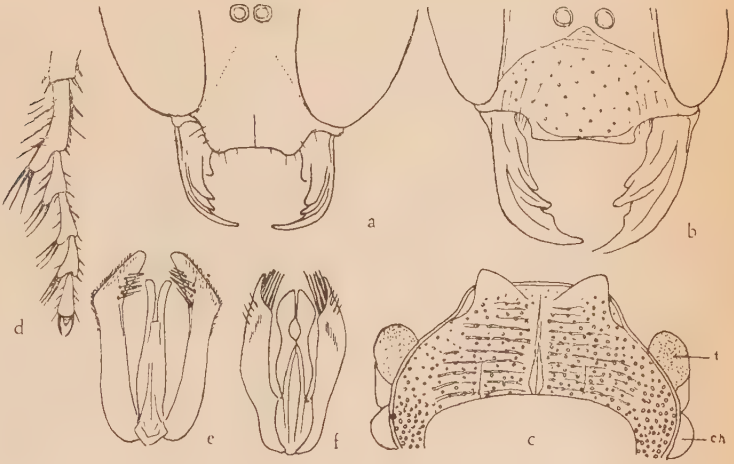


Figure 2

Ammophila algira Kohl ab. *bituberculata* ByS. ab. nov. a—clypeus ♂; b—clypeus ♀; c—mesonotum seen obliquely from in front ♀ (ch—callus humeralis, t—tegula); d—anterior tarsus ♀; e—genitalia ♂; f—*Ammophila affinis* Kirby, genitalia ♂.

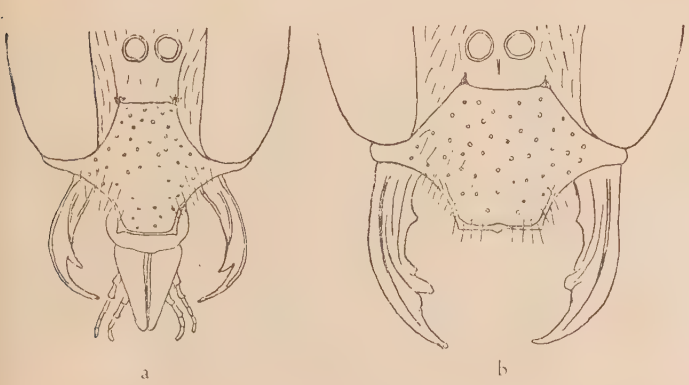


Figure 3

Ammophila sacra ByS. spec. nov. a—clypeus ♂; b—clypeus ♀.

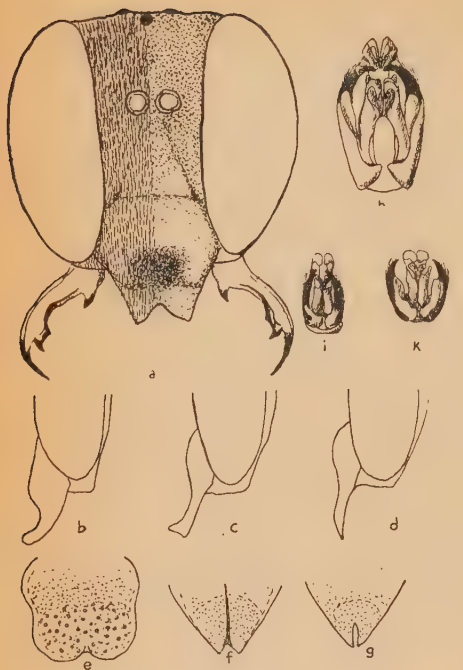
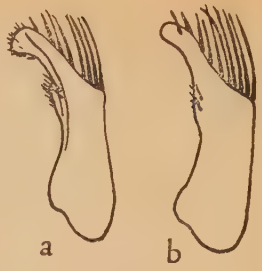


Figure 4

Ammophila pseudonasuta ByS. spec. nov. ♂ . a — head, left side showing the pubescence, right side the chitinous sculpture; b, e, h—clypeus in side view, 8th sternite, genitalia; c, f, i—*Ammophila nasuta* Lep., clypeus, 8th sternite, genitalia; d, g, k—*Ammophila nasuta* Lep. ssp. *atlantica* Roth, clypeus, 8th sternite, genitalia.

Figure 5 →

Valva of a—*Ammophila honorei* Alf.; b—*Ammophila apicalis* Brllé.



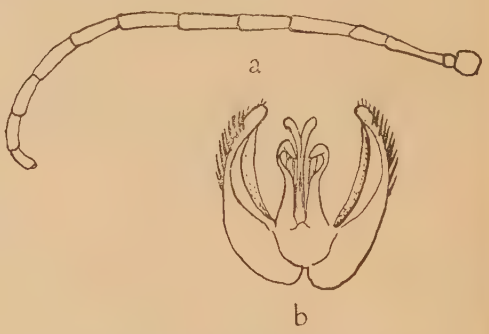


Figure 6

Sphex melanocnemis Kohl. a—antenna ♂ ; b—genitalia ♂ .

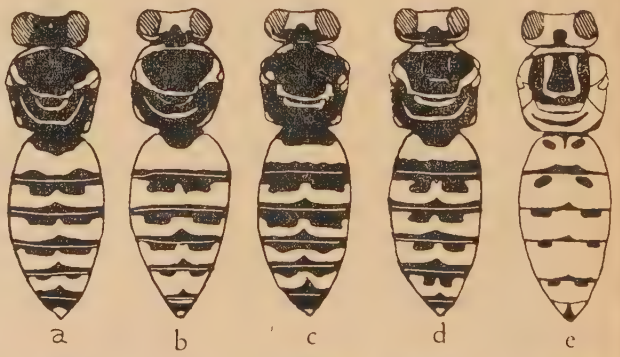
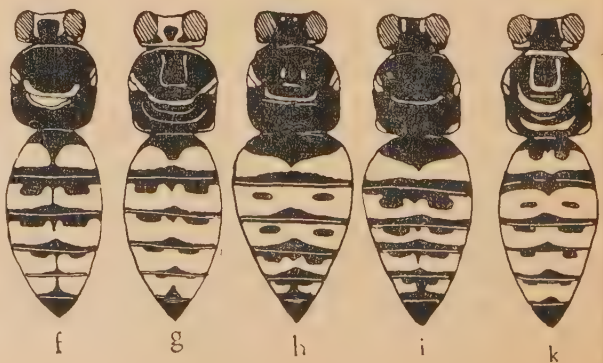


Figure 7 →

Coloration of the body of a—*Bembix holoni* ByS. spec. nov. ♀ ; b—*Bembix joëli* ByS. spec. nov. ♂ ; c—*Bembix cinctella* ssp. *enslini* ByS. ssp. nov. ♂ ; d — ♀ ; e—*Bembix dahlbomi* Hdl. ♀ ; f—*Bembix dahlbomi* ssp. *sabulosa* ByS. ssp. nov. ♂ ; g — ♀ ; h—*Bembix arenaria* Hdl. ♂ ; i—*Bembix turca* Dhlb. ssp. *picturata* ByS. ssp. nov. ♀ ; k—*Bembix radoszkowskyi* Hdl. ♂ .



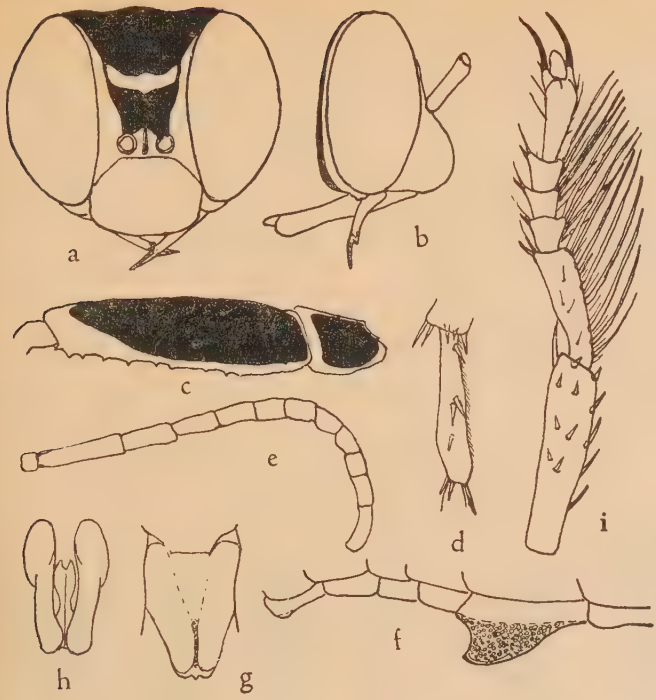


Figure 8

Bembix holoni ByS. spec. nov. a—head ♂, frontal view; b—head ♂, lateral view; c—middle femur ♂; d—middle metatarsus ♂; e—antenna ♂; f—abdominal sternites ♂, lateral view; g—7th sternite ♂; h—genitalia ♂; i—anterior tibia and tarsus ♀.

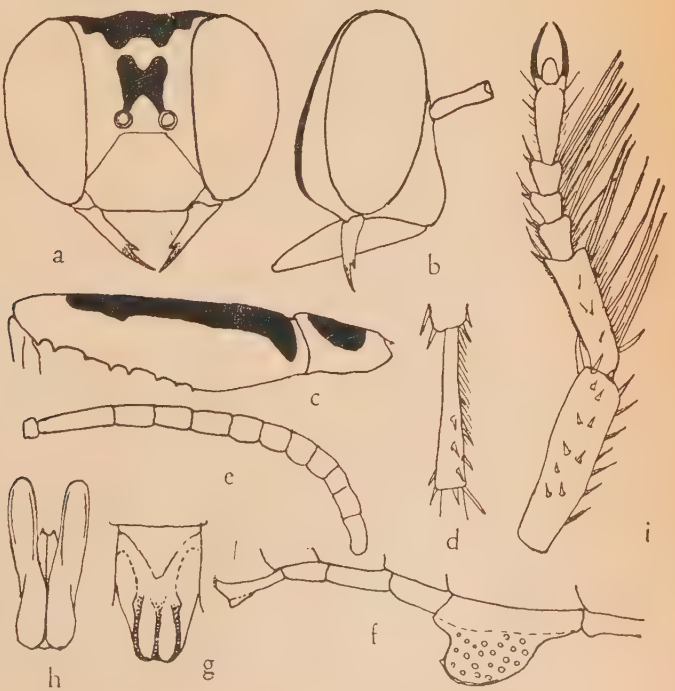


Figure 9

Bembix joëli ByS. spec. nov. a—head ♂, frontal view; b—head ♂, lateral view; c—middle femur ♂; d—middle metatarsus ♂; e—antenna ♂; f—abdominal sternites ♂, lateral view; g—7th sternite ♂; h—genitalia ♂; i—anterior tibia and tarsus ♀.

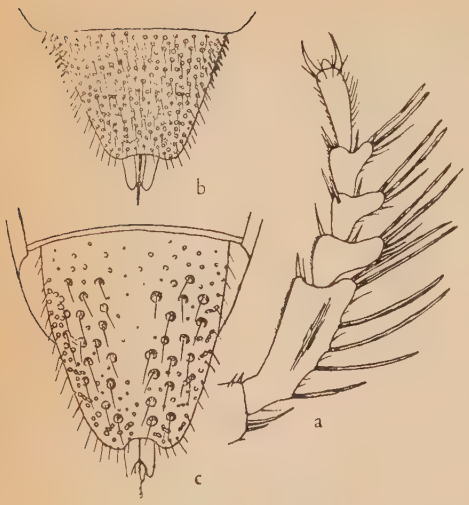
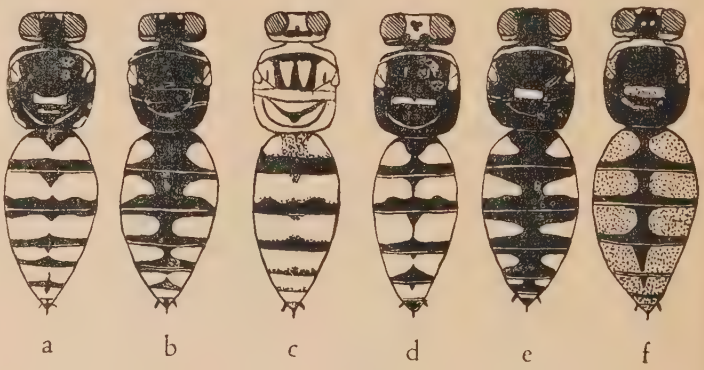


Figure 10

Stizoides verhoeffi ByS. spec. nov. ♀ . a — anterior tarsus; b — 6th tergite; c — 6th sternite.

Figure 11

Coloration of the body of a—*Stizus hebraeus* Balth. ♂ ; b — *Stizus fasciatus* F. ♂ ; c — *Stizus marthae* Hdl. ♂ ; d — *Stizus marthae* f. *cheops* Morice ♂ ; e — *Stizus ruficornis* F. ♂ ; f — *Stizus ruficornis* F. ssp. *eremicus* ByS. ssp. nov. ♂ .



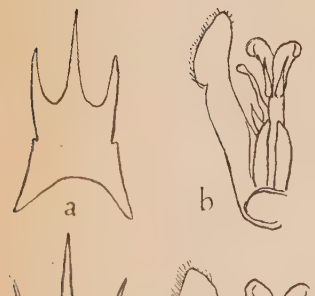


Figure 12

Stizus hebraeus Balth. a—7th sternite ♂ ; b — genitalia ♂ . *Stizus fasciatus* F. c—7th sternite ♂ ; d—genitalia ♂ .

NOTES ON THE ERIOPHYID MITES OF ISRAEL

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ABSTRACT

In his *Die Schaedlingsfauna Palaestinas* Bodenheimer (1930) mentioned 11 species of Eriophyid mites which are pests of varying extent to economic plants. Later, in 1937, in his comprehensive survey of the fauna of Palestine, the same author listed 32 species of Eriophyidae with their respective host plants, till then known to occur in this country. Since then, very little has been further reported regarding this family here. The only exception was the citrus rust mite, *Phyllocoptruta oleivorus* (Ashm.), which was found here for the first time in 1945 by Klein (1946), and its status, as up to 1950, lengthily discussed by Bodenheimer (1951).

Within ten years this mite has spread from three isolated foci so that it now covers practically the whole of the citrus-growing area in this country, thus becoming one of the major pests of Israel's citriculture.

The following notes concern Eriophyid species which hitherto have not been known to occur in this country, as well as further observations on species already reported.

THE OLIVE GALL-MITE, *ACERIA OLEAE* NAL.—A PEST OF OLIVES IN THE EASTERN MEDITERRANEAN BASIN

In 1904 Nalepa described in Vienna a new Eriophyid mite which he named *Eriophyes oleae*. It was found on deformed olive leaves sent to him from Cyprus. No detailed description of the nature of damage done to the olive tree was given by him. Since then, no further records have been published about the occurrence of this mite under the specific name mentioned above. However, for the last 20 years olive growers in this country have been constantly complaining about certain deformations of the young growth, resulting in the stunting of plants in the nurseries, as well as during the first 4—5 years in the orchard. Only in the summer of 1949 did the author succeed in determining the cause of that damage (1950), which was later identified as *Aceria* (=*Eriophyes*) *oleae* Nalepa.

The adult female is of a pale yellowish colour. Its body is of a vermiform shape, 0.120 mm long and 0.040 mm wide. The male is somewhat smaller, being only 0.100 mm long and 0.030 mm wide.

Damage

Due to the sucking of the mites the young leaves in the vicinity of the growth point become twisted (Figure 1) and, if infestation is severe enough, they will eventually die

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off. Mature leaves are also very often attacked. An infested mature leaf shows subcircular, sometimes irregular, green patches on its lower surface, which are quite distinct from the silvery background of the yet uninfected area. A microscopical examination of the lower surface of such a leaf reveals the mites wriggling around this patch. The impression of the infestation on the lower leaf-surface can also be recognized on the upper side as chlorotic areas corresponding to the lower-side patches. As a reaction to the mite's saliva injected into the leaf tissue, the infected patches develop into small bulges, thus giving the leaf an appearance of an embossed surface (Figure 1). Normally the lower side of the olive leaf is covered by a dense layer of umbrella-shaped hairs of a silvery colour. The green patches on the lower side of the infested leaves are the result of the destruction and shedding of these hairs, thus uncovering the green mesophyll. Within a short time these bald green patches turn brown, as necrosis progresses. In cases of heavier infestation the mites might even inhabit the upper leaf surface, should the population density on the lower surface exceed its limit.

Figure 1
Olive leaves deformed by the olive gall-mite.

Sucking along the leaf margins gives rise to remarkable sinuations resulting in the loss of the leaf's morphological regularity (Figure 1).

The galls formed on the olive leaves by this mite should not be confused with those caused by the olive gall midge, *Dasyneura oleae* Loew. The latter are real oblong blisters, inflated towards both leaf surfaces and they enclose the orange-coloured maggot in the centre, whereas those caused by the mite are either concave or convex hollow protuberances made of both leaf surfaces (Figure 2).

Apart from the leaves, this mite also attacks young olive fruits. The infested area of the fruit turns from green to silver and the regular shape of the young fruit is thereby deformed (Figure 3). The injured silvery area is generally spotted with minute brown specks which are tiny droplets of coagulated gum exuded from the affected skin of the fruit. The silvery areas eventually turn brown as the infected tissue undergoes final suberization. The mites first congregate in high numbers around the stem-end of the fruit where they can find shelter under the rudiments of the sepals. Then they invade the rest of the fruit's surface, concentrating mainly on its upper half. Fully developed fruits are much less susceptible to the attack of this pest.

The picture of damage as described above is very reminiscent of that caused by thrips, the principal difference being the origin of the brown specks spotting the silvery

background. In the case of thrips these are the insect's excrements, whereas in the gall-mite's case these are the plant's exudates. Furthermore, in this particular case even the injury done by this mite to the leaves also resembles, to a great extent, the damage caused by the olive thrips, *Liothrips oleae* Costa, in the central and western Mediterranean countries (Castro 1951). It therefore seems possible that Bodenheimer, while discussing the damage done by the olive thrips in Palestine (1930), largely included the injury of the olive gall-mite too. Later, in 1938, Klein likewise erroneously ascribed to the olive thrips the fruit deformations caused by the olive gall-mite. These views are well corroborated by the fact that the olive thrips proved to be very rare in this country, whereas the olive gall-mite is very abundant and harmful.

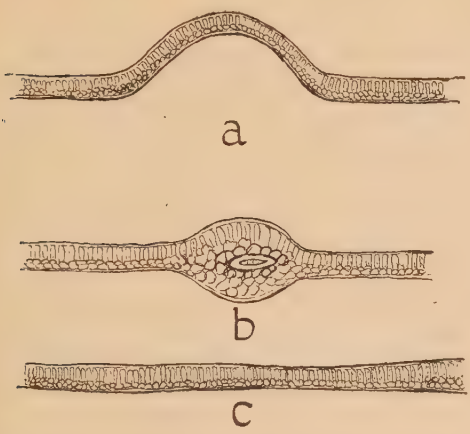

Figure 2
Diagrammatic cross-section of a leaf gall induced by: (a) olive gall-mite, (b) olive leaf gall-midge, *Dasyneura oleae* Loew, as compared with (c) the normal state.

Distribution

The mite was first discovered in the Upper Jordan Valley (Gesher, 15.VII.49). Since then, it has been found in all parts of Israel where olives grow. This pest seems to thrive particularly in the warmest parts of the country, namely the interior valleys situated below sea-level, viz., the Jordan, Beisan and Yizreel Valleys. The western Negev (Nirim and Revivim), the temperature of which is similar to that of the interior valleys, is also one of the areas where the pest was observed to be flourishing.

Figure 3
Young olive fruits deformed by the olive gall-mite.

An injury of olive leaves caused by an unidentified *Eriophyes* species in Middle Egypt was described by Hassan (1934) some 20 years ago. According to Hassan's description, that damage can now undoubtedly be attributed to *Aceria oleae* Nal. The same holds true for a similar case reported by Trotter from Libya (Graniti 1954, Trotter 1932). The places where Hassan reports the occurrence of this pest, the districts of Gizeh and Fayoum, are even hotter and drier than the Jordan or Beisan Valleys. Only very recently has Graniti (1954) reported the occurrence of this mite on olive trees in Sardinia, clearly indicating its novelty to the fauna of Italy. Hence, in accordance with its ecological requirements, this species seems to be limited in its geographical distribution to the eastern Mediterranean only, as it has never been reported from any of the other olive-growing regions, viz., the northern and western Mediterranean countries, California, South Africa, etc.

Noteworthy is a certain Eriophyid mite known to infest olive leaves in California, but this is a distinctively different species—*Oxypleurites maxwelli* Keifer (1939). The latter, commonly known as the olive leaf mite, does not cause the characteristic deformations as described above.

The highly favoured habitats of this mite are the young leaves and fruits growing on the most exposed aspects of the tree. The mites particularly prefer nurseries and well irrigated orchards growing on a heavier type of soil, where more humid conditions prevail. This, together with the geographical distribution of the mite, indicate its tropical or rather subtropical character.

So far, the olive tree (*Olea europaea* L.) has been found to be the only host of this mite. It is worthwhile mentioning that the botanical genus *Olea* is mainly tropical according to its phytogeographical distribution.

Economic importance

As stated before, the olive gall-mite prefers young and fresh olive plant tissues, fairly exposed to the sun in irrigated locations. Therefore, olive nurseries, as well as young plants in the orchards, will be most readily attacked. In the interior valleys the greater part of the new growth during the summer months of June—October is destroyed and the development of the plant is retarded, unless control measures are applied. Top-working and pruning of old olive trees, a practice widely employed in Israel nowadays, naturally induces a vigorous growth around the cut. These young shoots, and amongst them the newly grafted scions (in case of top-working) are most likely to be distorted by the pest. With the progress of the trees' growth and the subsequent closing up of the spaces among them, the importance of the pest decreases to a level lower than the economic threshold.

The damage caused to olive fruits in deforming their shape and diminishing their size is of particular importance with regard to the pickling varieties. Although fruit infestation is concentrated mainly on the tree's periphery, its rate nevertheless very often amounts to more than 50% of the total number of fruits.

All olive varieties grown in this country are attacked by the mite, including the local seedling root-stock *Melissi*. Although some differences in the extent of infestation have been observed among the various varieties, no consistent order of susceptibility could be established. The resistance of a certain olive variety to the mite's attack might

be only temporary owing to local horticultural conditions, viz. lack of new growth, inadequate irrigation, unfavourable exposure and the like (Avidov 1954).

Control

Although the mites can be seen on olive trees throughout the year, no control measures are needed during winter when activity is usually very low, being limited to a few hours only on sunny days. Noticeable increase of the population starts early in spring, continues through summer and goes on till late fall.

In olive nurseries in the Jordan Valley, trials carried out with sulphur powder secured satisfactory results in controlling this pest. Based upon the aforementioned observations on the seasonal activity of the mite, the first application should be given there as early as the end of March. This should be repeated twice during the summer, and if necessary a fourth application should be made in the autumn. Dusting with dry sulphur powder proved to be more effective in controlling this mite than spraying with wettable formulations of the same acaricide.

This mite, like all other members of the Eriophyid family, is devoid of ample locomotory means and is dependent solely on the wind for its dissemination. However, in many instances of spreading into new territories the pest is effectively aided by man through his careless transportation of infested olive plant material to mite-free areas. This is of particular significance for the Negev, since olives are an entirely new crop for that area. It is therefore needless to explain the necessity of implementing internal quarantine regulations in order to avoid the spreading of the pest to yet uninfested localities.

TOMATO RUSSET MITE, *VASATES LYCOPERSICI* (MASSEE)

In a recent revision of the gall-mites occurring on tomato plants, Lamb (1953) concludes that the tomato russet mite should be named *Vasates lycopersici* (Massee) 1937, *Phyllocoptes destructor* Keifer 1940 and *Vasates destructor* Keifer 1946 being only synonyms of the former. This mite is quite distinct from the tomato erineum mite, *Aceria lycopersici* (Wollfenstein). The latter has not yet been recorded here.

The measurements of local specimens of the tomato russet mite, taken from two different localities, were as follows:

Character	*Mean* μ	*Standard deviation*	*Coefficient of variation*
Length of body	175.9 ∓ 3.56	12.31	7.0
Width of body	61.6 ∓ 1.23	4.34	7.0

First stage larva measures $83\mu \times 40\mu$ on an average, while the mean body measurements of the second stage larva are $136\mu \times 52\mu$.

A comparison of the body measurements of local specimens with those of New Zealand, the United States, Morocco and England — as reported by Lamb (1953) — shows that ours fall well within the range of distribution of body size of this species.

The tomato russet mite was found for the first time in this country by the author (1950) in the summer of 1949. The mites first inhabit the upper surface of the tomato leaves, which as a result turn greyish-brown with a slight bronze shine, thus showing the typical russety appearance. They were observed to congregate along the leaf veins, mainly along the central one. When population density on the upper surface reaches its peak (over 100 mites per one young tomato leaf), the mites start migrating to the lower surface, favouring the main nerves there, too. Young green tomato fruits were also seen to be attacked quite often. The injured fruit shows small rusty spots of about 0.5 mm in diameter, each of which consists of numerous microscopical punctures. Mites were also found on the main tomato plant stalk, as well as on leaf stems. Infestation of these plant tissues results in cracking of the green bark into oblong crevices of 0.5—2.0 mm in length.

Generally, the picture of the injury in this country under outdoor conditions is very similar to the one described by Bailey and Keifer (1943) as regards greenhouse tomatoes in central and northern California.

The mite is active here throughout the year. The peak of its activity, including reproduction, is witnessed during the hottest season of the year, namely July—October. In this season many of the infested plants are completely destroyed by the pest, unless control measures are applied.

The distribution of the tomato russet mite in Israel ranges from the northern Negev through the Coastal Plain and the Yizreel Valley to the Jordan Valley, the latter being the worst mite-ridden area in the country. In all these regions tomatoes and other nightshade plants are grown outdoors the whole year round. So far the occurrence of this mite in the cooler hilly areas has not been recorded.

In tomato fields frequently treated with DDT the extent of russet mite infestation is invariably much greater than in fields where no DDT has been applied. In most cases, however, sulphur dusting at fortnightly intervals proves fairly satisfactory in controlling this pest.

PEAR BUD MITE, *ERIOPHYES PIRI* (PAGST.)

This species has apparently been imported into this country through careless introduction of infested pear seedlings, in the early thirties of this century. It was found here for the first time by Klein at Miqve Israel in 1935. Since then, it has spread throughout the Coastal Plain.

So far, only leaf blistering forms have been observed here, while the well-known bud deformations caused by this same mite abroad have not yet been recorded. The damage done to pear trees in this country is still limited and in most cases is of no economic significance.

CITRUS BUD MITE, *ACERIA* (= *ERIOPHYES*) *SHELDONI* (EWING)

For many years citriculturists in this country, as well as abroad, used to speak about "teratological forms due to some unknown physiological disorders" when referring to lemon and other citrus fruits of a pronouncedly grotesque shape. Only about fifteen years ago it was established that in most cases these "teratological fruits" develop from blossoms injured by the citrus bud mite (Figure 4). Our findings in this respect stand in perfect agreement with those of Boyce et al. (1942), who comprehensively studied this mite in California. The first specimens to be identified as *A. sheldoni* (Ewing) were collected only quite recently by the author on deformed young lemon fruits (Rehovot 14.V.1954). It should, however, be stressed that, although the citrus fruit deformations induced by the bud mite are quite characteristic, occurrence of the mite should not be established solely upon the presence of deformed fruits. Only the identity of specimens recovered from the affected trees should be accepted as evidence for occurrence. It has already been shown by Jeppson (1951) that a characteristic deformity of lime fruit in the form of ridges and excrescences in California was not caused by the citrus bud mite, as had been previously suspected.

The bud mite occurs here mainly on lemons and only to a limited extent on oranges and other citrus varieties. Nearly in all cases the damage, however, is as yet of no economic importance.

Figure 4
Deformed lemon fruits which developed from blossoms affected by the citrus bud mite, *Aceria sheldoni* (Ewing). (By courtesy of Dr. K. Mendel).

CECIDOPHYES MALPIGHIANUS (CAN. ET MASSAL.)

This mite is known in Europe as causing bud deformation on *Laurus nobilis* (Nalepa 1929). Here it was found to cause rather a thick brown erineum on the lower surface of the leaves of the above-mentioned host plant (Tarbiha, Upper Galilee, 2.III.1950). When fully developed this erineum covers nearly all the lower surface of the infested laurel leaf.

It is not unusual among Eriophyidae that mites with the same morphological characteristics should show a comparable diversity in their host damage, as previously described in the case of the olive gall-mite.

ACERIA (= *ERIOPHYES*) *ILICIS* (CAN.)

The occurrence of this mite on the different oak trees in Palestine, together with its inquiline *Phyllocoptes rostratus* Fock., has already been reported by Bodenheimer (1930).

It should, however, be added that the erineum caused by the local *A. ilicis* is of the papillate type, which is altogether different from the hairy, pocket erineum caused by *Eriophyes ilicis typicus**.

According to Nalepa's (1929) classification of this species, this seems sufficient to warrant the placing of the local oak erineum-mite as a distinct variety of *A. ilicis* (Can.). But, owing to the still little known fact that gall-mites, like many other gall-producing insects, show a wide range of heteromorphism with regards to their host-damage, the aforementioned subspecific naming should be avoided. Hence, in the particular case of the oak erineum-mite, as long as no morphological differences have been established between the local and the European specimens, any taxonomic distinction between them is still premature.

TEGONOTUS SP.

This mite was found in very small numbers on olive leaves (Mishmar David, 22.XII. 1950). It is a rust mite type, to which no economic importance can yet be attached.

ACKNOWLEDGMENT

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A STRAIN OF *PSEUDOMONAS* ISOLATED FROM DISEASED BANANA PLANTS *

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ABSTRACT

From April to November 1954, a green fluorescent bacterium was isolated along with other organisms from diseased banana plants grown in the Jordan Valley. The organism produced lesions on citrus, avocado, tomato and pepper fruits, on young pods of pea, and on lettuce and tomato leaves, but not on banana.

Examination of the organism indicates that it should be identified as a strain of *Ps. polycolor* or *Ps. aeruginosa*. Injection of the organism into mice caused death after 24 hours.

From April to November 1954, a green fluorescent bacterium, along with other organisms, was isolated on nutrient + 1% glycerol agar plates, from the discoloured vessels of the partially darkened and often rotted trunk, base of the leaf, and bulb of several diseased banana plants grown in the Jordan Valley. In longitudinal sections, the vascular bundles in the discoloured area were dark-brown or black, and were polluted with numerous bacteria. A number of inoculation experiments made with the organism under various conditions failed, however, to produce any infection on healthy banana plants.

On the other hand, the organism produced lesions on citrus, avocado, tomato and pepper fruits, on young pods of pea, and on lettuce and tomato leaves. Healthy unripe fruits or leaves were inoculated either by pricking through drops of a sterile distilled water suspension of 48 hr old slant cultures, or by smearing the leaves with the suspension after water-soaking them with a fine syringe (Volcani 1950). The leaves were then sprayed with sterile water and kept along with the fruits in bell-jars over water at temperatures of 14—37°C.

Within 2 to 6 days the inoculated lemon, grapefruit and orange fruits developed typical black pit lesions (Figures 1 and 2), while the inoculated tomato and pepper fruits showed deeply sunken, hard, brown spots, surrounded with a darker narrow ring. Quite often a soft, light-brown zone developed around the necrotic spots of inoculated tomato fruits at 34 and 37°C (Figures 2 and 3). On unripe avocado fruits and pods of pea, deeply sunken, hard, necrotic spots developed around centres of inoculation (Figures 4 and 5). With peas, the infection penetrated from the pod-skin into the seed of pea which turned black; the skin was shrunken, and the interior was affected with a soft rot. On avocado, infection penetrated from the skin into the flesh of the

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fruit, discolouring it and causing a slight hardening of the parenchyma tissue. Hard, necrotic, brown spots developed on both pricked and smeared tomato leaves, while transparent, light-brown spots developed on lettuce leaves. Various vegetables inoculated with the organism under laboratory conditions did not develop soft rot of the parenchyma. A deep blue-green pigment developed on potato and onion slices in water. The optimal temperature for infection was between 28—32°C. Very slight infection was induced at 14°C, and good infection was produced at 34 and 37°C.

Infection experiments with re-isolations from lesions of all specimens gave similar results. The reisolated organisms were identical with the original isolation. Histological sections showed numerous bacteria in the parenchyma tissue of infected parts. No infection resulted when drops of suspension were not pricked into the fruit. Control pricked through drops of sterile distilled water did not develop any sort of infection.

Examination of the organism shows that it belongs to the genus *Pseudomonas* Migula (Breed et al. 1948). It is a Gram negative short rod, motile with one or two polar flagella, and produces green fluorescent pigment in culture. Its optimal growth temperature is at 30°, minimum at 9° and maximum at 43°C; thermal death point approx. 54°C. Many morphological, physiological and pathological characteristics are similar to those of *Pseudomonas syringae* Van Hall (Breed et al. 1948; Elliott 1951; Volcani 1946, 1950, 1954), but it differs in its minimum-maximum growth and optimal-maximum pathogenicity temperatures which are markedly higher. On the other hand, the organism taken from the banana plant shows some relationship with *Pseudomonas polycolor* Clara (Breed et al. 1948, Elliott 1951), the causal organism of a spot disease on tobacco, which, according to Elrod and Braun (1941, 1942) is identical with *Pseudomonas aeruginosa* (Schroeter) Migula (Breed et al. 1948), and is fatal to laboratory animals. With both the organism from the banana plant and *Ps. polycolor*, the temperature relations are relatively high (Breed et al. 1948), both of them produce deep green-blue pigment on nutrient glycerol agar (Elrod and Braun 1942), and both are pathogenic to lettuce (Elrod and Braun 1942).

In order to determine with which of the two species the organism from the banana plant should be identified, the latter was examined simultaneously with isolates of *Ps. syringae* from lemon and from avocado fruits, and with a culture of *Ps. polycolor* sent from Cambridge by Dr. Dowson. In addition, *Ps. polycolor* was inoculated into lettuce, lemon, grapefruit, avocado and tomato fruits, and pods of pea, while the organism from the banana plant was injected intraperitoneally into mice (0.1 cc of a saline suspension of a 24 hr old nutrient agar slant culture)*.

The results of the examination and inoculation experiments show: (1) All four organisms produce similar reactions on carbohydrates incorporated in an inorganic basal medium with either Andrade, or brom thymol blue as indicator; the only differences among the organisms are, that both isolates of *Ps. syringae* show strong acid reactions on sucrose, while with the banana organism and *Ps. polycolor* there is no acid reaction with Andrade, and only a very weak reaction with brom thymol blue. (2) Like both the organism from the banana plant and other varieties of *Ps. syringae* (Elliott 1951; Volcani 1946, 1950, 1954), *Ps. polycolor* is pathogenic to lettuce, pods of pea and tomato fruits, but

* Experiments with mice were made in the Department of Bacteriology, The Hebrew University of Jerusalem.

to a lesser degree to avocado and citrus fruits; its optimal and maximum pathogenicity temperatures are similar to that of the organism from the banana plant. While the lesions induced on citrus fruits with the banana organism and *Ps. syringae* appear as deeply sunken spots attaining a diameter of a 0.5—1.0 cm, those induced with *Ps. polycolor* are limited mainly to the punctured area and appear as brown-reddish, slightly sunken or almost flat small spots. (3) Injection of a saline suspension of the banana organism into mice caused death after 24 hours.

The above results indicate that the organism from the banana plant should be identified with *Ps. polycolor* or *Ps. aeruginosa*. In view of its distinct ability to produce typical black pit lesions on citrus fruits, the organism from the banana plant was finally identified as a strain of the latter species.

ACKNOWLEDGMENT

The author wishes to express her thanks to Prof. M. Ashner for his generous cooperation in carrying out the tests with mice, to Miss D. Godinger of his staff for helping in these experiments, and to Dr. W. J. Dowson for providing a culture of *Ps. polycolor*, and for his kind suggestions with regard to the identification of the organism.

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Figure 1
Inoculated unripe pepper and lemon fruits showing deeply sunken brown spots: the 1st and 3rd fruits were kept at 37°C and the 2nd at 28°C.

Figure 2
Inoculated unripe avocado fruit showing deeply sunken, small dark spots at 30°C.

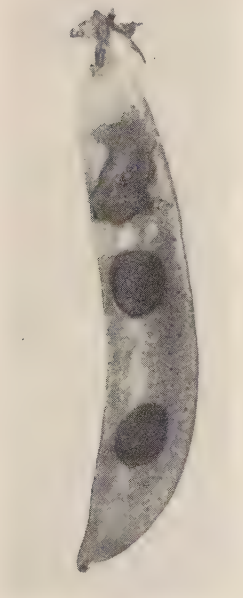

Figure 3
Inoculated young pod of pea showing deeply sunken brown spots at 30°C.

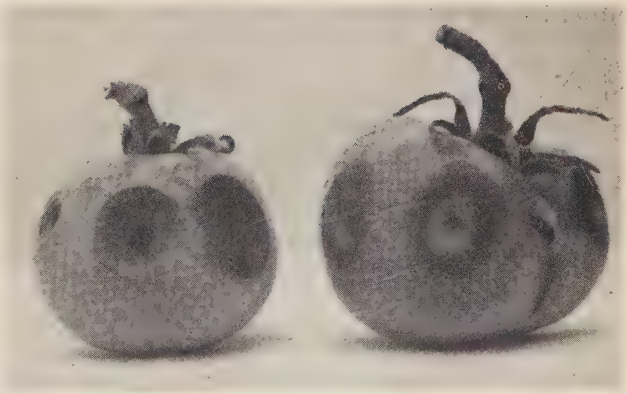

Figure 4
The left hand tomato fruit shows deeply sunken dark brown spots at 28°C; the right hand fruit shows brown necrotic spot surrounded by a light brown soft zone at 37°C.

ESTIMATING THE DEGREE OF DETERIORATION IN STORED BRAN BY MICROSCOPIC ANALYSIS *

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ABSTRACT

Bran was stored at 20°C and at three levels of relative humidity for up to 18 months, to determine the biological and chemical changes occurring at each level, as indicated by bacterial and fungal populations and by general fat and free fatty acid content. The purpose of the work was to develop reliable microscopic methods for the evaluation of the state of deterioration in stored bran. It was shown that fungi, rather than bacteria, are the chief agents of decomposition. Since mycological determinations based on colony counts and examinations of mycelia proved to be of limited applicability within normal population ranges, a microscopic method based on chemical changes was sought. It was found that where deterioration is due to ageing alone, general fat percentages remain relatively constant, but the amount of free fatty acids gradually increases. On the other hand, where deterioration is due to fungal activity, the general fat percentage steadily decreases, but the free fatty acids content rises sharply at first and then decreases, falling even below the normal for fresh bran. A histochemical microscopic method, based on these changes in fat content, was devised, in which the base of toluylene chloride is used to stain the aleurone cells of the bran. A yellow stain indicates a high glyceride content. With increasing accumulation of free fatty acids, the colour ranges through orange to a clear red, providing a reliable indication of deterioration.

For the estimation of insect infestation, a method for separating insects and insect-parts and excreta from the bran is described: a ligroin-ethylene dibromide mixture is recommended for beetle-counts, and an alcohol-ligroin combination for worm-counts. A quick method for estimating the amount of insect excreta is described, based on the addition of a weighed amount of *Lycopodium* spores to the sifted remainder of a weighed bran sample.

INTRODUCTION

Concentrated feeds such as brans, cakes, and feed-meals are liable to serious deterioration during storage, with resulting loss of palatability and nutritional value (Jacquot et al. 1947, Lepkowsky 1948, Ruemele 1935). Deterioration involves both chemical and biological changes: it may be due to ageing alone, i.e., enzymatic and/or oxidative processes, or to the activity of various insects, pests, and microorganisms. The moulds in particular are responsible for the decomposition of fats, carbohydrates, and proteins (Foster 1949), and the presence of their mycelium is evidence, per se, of spoilage. Moreover, even though fungal activity has been halted, feeds once infected are more susceptible to deterioration and hence harder to store than fresh feeds. Feeds which have deteriorated due to age alone are readily attacked by moulds under conditions in which fresh feeds are safe. It is highly desirable, therefore, to evaluate the degree of deterioration in feeds before, during, and after storage.

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Though chemical and biological changes are inter-related, their evaluation does not, by itself, adequately describe the state of the feed. Moreover, chemical assays, though useful in some respects, are both time-consuming and expensive. Relatively quicker and cheaper microscopic tests have been developed for flours, to reveal adulteration, to estimate the degree of insect infestation, and to detect fungal activity by mycological methods and by examination for mycelia.

These tests do not, however, provide any information concerning chemical changes, and give only limited information concerning the biological state: (1) Existing methods for estimating insect infestation (AOAC 1945, Harris and Elliot 1943, Howard 1939, Kent-Jones and Amos 1947, Kent-Jones et al. 1948, FDA 1944) cannot be used for feeds, owing to the presence of the grain coats. (2) It has not yet been determined whether bacterial and fungal counts provide an accurate test for biological changes in feeds. (3) Examination for mycelia may be quite misleading, because in dried-out feeds the mycelia already present may be destroyed and the development of new ones arrested, and because some destructive fungi, under certain conditions, do not develop any mycelia at all.

It seemed important, therefore, to develop reliable microscopic methods for evaluating both the chemical and biological status of stored feeds. This paper reports a histochemical method for estimating deterioration due either to chemical (i.e., ageing) or to microbiological factors, and an improved technique for estimating the number of insects and insect excreta.

Bran, being one of the most important feeds, was chosen for this work.

I. THE EVALUATION OF MICROBIOLOGICAL CHANGES IN STORED BRAN BY MICROSCOPIC ANALYSIS

Since tests for mycelia do not reliably detect fungal activity (and hence deterioration) in bran, it was thought that changes in bacterial and/or fungal populations might be indicative. Experiments were therefore carried out to determine the changes in microbiological population occurring in bran stored at three levels of relative humidity for up to 18 months.

EXPERIMENTAL

Relative humidity was selected for detailed study, since the moisture content of the bran, which conditions both deterioration and mould development, is determined by the relative humidity. Furthermore, at the same relative humidity, the actual moisture content as well as the moisture level favouring deterioration, differ in various feedstuffs (Snow et al. 1944).

Materials and methods

In most of the experiments bran samples were kept at 20° C. Four samples were used in each trial.

25 g samples of bran were stored for various periods in close-mesh baskets which were suspended in a closed vessel over a thin layer of a saturated salt solution (Spencer 1926), selected to give the following r.h. levels:

(a) *High*: 93%, which is conducive to deterioration; obtained with $Na_2SO_4.10H_2O$.

(b) *Intermediate*: 76%, at which most xerophytic fungi can still develop (Barton-Wright and Tomkins 1940, Christensen et al. 1949, Gilman and Semeniuk 1948, Milner and Geddes 1946); obtained with NaCl.

(c) *Low*: 58%, which prevents microbiological activity (any deterioration, at this r.h., can only result from ageing); obtained with $KBr.2H_2O$.

The number of fungi was determined by using Christensen's culturing method (Christensen 1946) which prevents the growth of bacteria but provides for good growth of fungal colonies. Bacteria counts were made according to Cereal Laboratory Methods (AACC 1947).

RESULTS

The microbial population in fresh bran was determined in a preliminary study. In 10 samples, the bacterial population per gram ranged from approximately 4 to 12 million and the fungal population from 2,000 to 7,000. Such a great range of variations in the microbial population of fresh bran clearly indicated that the number of bacteria and fungi could not, by itself, provide a satisfactory index of deterioration in the stored bran.

Results of experiments to determine the microbiological changes in stored bran are given in Table I. It may be seen that at all humidity levels the bacterial population steadily decreased. It is evident, therefore, that bacteria are not agents of deterioration in bran. This accords with the reports of other workers (Gustafson and Parfitt 1933, Kent-Jones and Amos 1930, Thom and Le Fèvre 1921) regarding wheat flours and corn-meal.

TABLE I

Number of bacteria and fungi in 1 g of bran stored at 20°C and at different levels of relative humidity

Storage period (weeks)	*Relative Humidity*					
	58%		76%		93%	
	Fungi (thousands)	*Bacteria (millions)*	*Fungi (thousands)*	*Bacteria (millions)*	*Fungi (thousands)*	*Bacteria (millions)*
0	2.38	5.91	2.38	5.91	2.38	5.91
2	2.42	4.49	2.47	4.62	140.46	2.68
4	2.23	3.30	2.59	4.00	18208.40	0.68
6	2.16	2.70	2.68	3.68		0.20
8	2.11	2.66	2.78	3.36		0.07
10	2.06	2.62	2.94	3.29		0.02
12	2.02	2.60	3.16	3.16		
14	2.00	2.56	3.49	3.00		
16	1.92	2.54	3.90	2.85		
18	1.88	2.51	4.52	2.65		
20	1.83	2.50	5.23	2.37		

The fungal population, however, decreased with storage at low r.h. but increased rapidly at higher levels, reaching in some cases as much as 18 million after only 4 weeks at r.h. 93% — enormously more than the number found in fresh bran. It may be concluded, therefore, that fungi rather than bacteria are the chief biological agents of deterioration in bran.

Number of fungal colonies as an index of deterioration

Since there is great variation in the fungal populations of different lots of fresh bran, it is clear that, unless the bran is seriously infected, only the *increase* in fungal population during storage is indicative of deterioration. Thus, as Table I shows, 1 g samples of bran stored for 20 weeks at 76% r.h. had a fungi-count of 5,230. This is within the limit of natural inoculum. Only by comparison with counts made before storage — in this case, 2,380 — can it be seen that a considerable increase in fungal activity has taken place, and that deterioration is well advanced. However, in the bran stored for only 2 weeks at 93% r.h. the number of colonies in 1 g of bran was 140,460 — far beyond the permissible limit for fresh bran and a clear indication of serious deterioration.

It is very significant that, in spite of the increase in fungal activity in bran stored at 76% r.h., no mycelia could be detected at any time during the storage period. It appears, therefore, that the fungi reproduced without producing mycelia. This is in accordance with Foster's finding (1949) that moulds in unsuitable growth conditions reproduce like yeasts; i.e., germinating spores produce short vegetative cells that divide without the appearance of any form of mycelium.

It was clear from the above results that mycological tests are useful only where extreme deterioration has been reached, or where both pre-and post-storage fungal populations can be compared, and that microscopic methods of more general application must be sought in other directions.

II. THE EVALUATION OF CHEMICAL CHANGES IN STORED BRAN BY MICROSCOPIC ANALYSIS

As little information is available concerning those chemical changes in stored bran which are diagnostic of deterioration, it was necessary to determine what changes occur. Two indices were selected: general fat percentage, and free fatty acids content.

The possibility that the latter might serve as an indicator of deterioration in bran was suggested by the findings of Zeleny and Coleman (1938), that the free fatty acids content provides a much better indicator of the health of maize and wheat seeds than "general acidity". These authors report a very clear inverse correlation between the health of the seeds (as shown by germination percentages) and their free fatty acids content. This may be due to the fact that the free fatty acids appear in the first stage of deterioration, before the other types of acidity have developed. They found, furthermore, that, as deterioration progresses, acidity due to free fatty acids increases much faster than does that due to other types of acids.

"General acidity", on the other hand, expresses different quantities of three types of acidity — fatty acids, amino acids, and acid phosphates — depending on the extraction and titration methods used, and is therefore less reliable.

EXPERIMENTAL

Bran samples were stored under the conditions described in the previous section. Free fatty acids determinations were made according to the method of Zeleny and Coleman, in which the result is expressed as mg of KOH required to neutralize the free fatty acids derived from 100 g of dry matter. Petroleum-ether extraction was used for the general fat assays.

TABLE II

Fat percentage and free fatty acids content in bran stored at 20°C and at different levels of relative humidity

Storage period (months)	Relative Humidity					
	58%		76%		93%	
	Fat (%)	Free fatty acids*	Fat (%)	Free fatty acids*	Fat (%)	Free fatty acids*
0	4.82	80	4.82	80	4.82	80
1	4.82	95	4.82	97	1.37	63
2	4.80	111	4.81	117	0.60	37
3	4.82	125	4.82	122	0.265	17
4	4.81	142	4.82	150	0.263	15
5	4.82	162	4.80	185	0.264	10
6	4.83	186	4.78	220		
7	4.82	204	4.62	262		
8	4.80	225	4.48	338		
9	4.80	246	4.37	380		
10	4.79	272	4.13	362		
11	4.80	302	3.90	330		
12	4.80	331	3.67	307		
13	4.78	352	3.40	270		
14	4.77	369	3.11	198		
15	4.74	385	2.80	114		
16	4.72	404	2.40	78		
17	4.71	427	1.95	52		
18	4.68	443	1.41	32		

* Expressed in mg of KOH required to neutralize the acids derived from 100 g (dry weight) of bran.

RESULTS

General fat percentage

As Table II shows, bran stored at low r.h. lost almost no fat. After 6 months at intermediate r.h., however, fat content began to decrease fairly rapidly; after 9 months the rate of decline steadily increased until, by the end of 18 months, 70% of the general fat had been lost. At high r.h. the fat loss proceeded very rapidly during the first month, after which it reached a very low but fixed level which apparently represents that part of the general fat which does not saponify.

Free fatty acids

As the bran ages, the amount of free fatty acids rises. At favourable storage conditions (e.g., 58% r.h.) it increases gradually, as is shown in Table II. In less favourable conditions allowing the growth of fungi, the free fatty acids content rises rather rapidly to a certain point and then decreases, falling far below the original level. At high r.h., the free fatty acids content decreases immediately, until by only 5 months' storage it has decreased to $^1/_8$ the original amount.

These changes in chemical composition may be explained as follows: at suitable r.h. levels, chemical change is caused only by enzymatic hydrolysis, which results in the

gradual increase in free fatty acids as the fats are broken down. At higher r.h. favouring the growth of microorganisms, however, the decomposition of fats and the formation of free fatty acids is hastened by the lipolytic activity of the organisms which utilize the acids. When the point is reached where the requirements of the increased population exceed the rate of fat decomposition, there is a rapid decrease in the amount of acids. At very high r.h. the profuse growth of microorganisms results in great and rapid consumption of fatty acids; it is likely that fatty acid assays during the first few days of storage would show that the decrease is preceded by a large increase.

A HISTOCHEMICAL TEST FOR ESTIMATING DETERIORATION IN STORED BRAN

Since it was found that deterioration in stored bran, whether due to ageing or to fungal activity, is accompanied by decomposition of the fats, a histochemical microscopic test was sought which would quickly and reliably indicate these changes.

The aleurone tissue was selected for this purpose, as it is particularly rich in fats: 94% of the general fat content of the grain coat is concentrated in the aleurone and hyaline layers — which usually occur together — and the cell contents of the aleurone layer (excluding the cell walls) contain 50% fat (Bames et al. 1938, Shetlar et al. 1947).

Reagents

Of the various reagents tested, best results were obtained with "neutral red" (toluylene chloride) used by Knaysi (1941) for detecting lipolytic activity of bacteria cultured on a fat-containing medium. For our purposes, it was found that the base of this reagent must be used. The base was liberated from its salt solution as follows: normal NaOH was added, drop by drop, to a 0.2% solution of the reagent until the base precipitated out. After filtering and washing the yellow precipitate in distilled water (with a *p*H of 7.5—8.0 to prevent re-formation of the salts), it was dissolved in 75% alcohol.

Procedure

The procedure is quick and simple: the floury portion is sifted out, the coats are spread out on a microscopic slide, and the reagent is added and allowed to remain for 10 minutes. Microscopic examination can then be made. When dissolved in the fat of the aleurone cells, the reagent-base turns the fat yellow. The free fatty acids, however, unite with the base to form red salts. Thus, decisively red-stained cells always indicate that the free fatty acid content, according to the scale of Zeleny and Coleman, is more than 300 and hence, that deterioration is due either to fungal activity or to ageing of at least a year's duration.

Various shades, ranging from yellow through orange to true red, indicate the degree of hydrolysis that has taken place; i.e., the relative amounts of free fatty acids and glycerides present in the cells. Experience is necessary to evaluate the intermediate stages, but it is easy to distinguish fresh bran in which the cells stain yellow or slightly orange, from deteriorated bran in which the cells turn clear red.

In bran which is very old, or in which there has been prolonged microbiological activity, not only the aleurone cells but the entire sample turns red to violet. The latter colour is apparently due to the low *p*H resulting from fungal activity.

Where it is suspected that the bran has been subject to strong attack by fungi (e.g., if the bran has been wetted), which would result in almost complete decomposition of the fats and consumption of the free fatty acids, the following modification can be used: Sifted coats are percolated with alcohol to dissolve any remaining free fatty acids and leave the glycerides, and are then moistened with an alcohol solution of Sudan IV — a specific fat reagent. After 15 — 20 minutes the bran is washed quickly, first with 70% alcohol and then with water, and is examined microscopically through glycerine. If the aleurone cells are not stained by the reagent, or if the stain is pale, it may be assumed — even if no mycelia are visible — that the bran has indeed been subjected to very considerable fungal activity with consequent total decomposition of the fat.

For greater accuracy, further chemical analysis can then be made. If, for instance, a microscopic analysis which has indicated considerable amounts of free fatty acids is followed by chemical analysis which shows that fat percentage is normal, it may be concluded that the bran is very old. Fat percentage much lower than normal serves as an indication that the bran has been subjected to considerable fungal activity.

The histochemical microscopic method described thus gives a quick and dependable estimation of the state of the bran.

III. MICROSCOPIC METHODS FOR ESTIMATING INSECT INFESTATION IN STORED BRAN

Insects not only consume the feed itself, but their activity hastens deterioration and decomposition: their respiration increases the danger of "heating" with consequent aggregation of the meal, and their excreta provide an excellent substrate for destructive fungi and bacteria (Good 1936). Bran so affected is unpalatable and may even cause digestive and respiratory disturbances in animals.

Infestation by insects and, particularly, by mites usually indicates that the bran has been stored for some time (Hughes 1948); furthermore, the presence of certain pests (*Calandra granania* and *Tinea granella* or *Ephestia kutniella*) is evidence that the bran has been adulterated with refuse from the cleaning process. The degree of insect infestation may be estimated by counting either the number of insects and insect remnants, or the number of insect excreta, or both, present in a representative sample.

NUMBER OF INSECTS

Separation of the insects by flotation in mineral oil from the enzymatically digested or hydrolyzed foodstuffs — used in determining insect contamination of flours (AOAC 1945, Kent-Jones and Amos 1947, Kent-Jones et al. 1948, FDA 1944) — cannot be used with bran because the specific gravity and oleophilic characteristics of the grain coats are similar to those of the insects and, thereby, prevent separation by this method. Another method for separating out the insects was therefore sought.

Separating agents

After a number of trials it was found that the insects can easily be separated and removed from the bran if the sample is shaken in any of the three following types of liquids:

(1) *Ligroin.*

(2) *Ligroin and ethylene dibromide:* Since the specific gravity of ligroin is low (0.63 — 0.66), while that of ethylene dibromide is high (2.17), they can be combined in

proportions that will cause the bran to sink and the insects to float on the surface. The most suitable ratio was found to be 10 parts ligroin and 6—8 parts ethylene dibromide. It was found, also, that this mixture is a good wetting agent with respect to the insect surfaces.

(3) *Ligroin and alcohol*: The bran sample is well shaken with a ligroin-saturated alcohol mixture; then an alcohol-saturated ligroin mixture is added and the whole again shaken well. After standing for a few minutes, the alcohol sinks carrying the bran with it, while the ligroin rises, floating the insects to the top.

Procedure

Two types of vessels can be used: an Erlenmeyer flask, stoppered with a cork; or a separating funnel in which the tap has been replaced by a rubber outlet tube, at least 1 cm in diameter, which can be closed with a clamp. The insect-containing layer is poured into a Buchner funnel lined with smooth filter paper. After the number of whole insects has been counted macroscopically, the paper is moistened with clove oil and transferred to a Petri dish for microscopic examination.

It was found that the ligroin-ethylene dibromide mixture was the most efficient for determining the number of beetles; the saturated alcohol-ligroin mixture gave best results for the worm-counts. Ligroin alone was not as efficient as either of the mixtures.

AMOUNT OF INSECT EXCRETA

The length of time during which insects have been active in the bran is indicated by the amount of insect excreta. In some samples no insects were found, but the presence of excreta indicated that the bran had once been infested. The quantity of excreta, therefore, is an important index of the state of the bran and should not be neglected.

Procedure

For a rough indication of the amount of excreta present, the ligroin-alcohol method outlined above proved satisfactory. Counting all the pellets, however, is too time-and effort-consuming; a better method was therefore sought.

It has been found in the course of the experiments that even pellets 500μ in length can be separated from the bran coats with a 0.5 mm sieve. The following procedure was therefore adopted: 50 mg of *Lycopodium* spores are added to the sifted, pellet-containing remainder of a 10 g bran sample. The whole is then well mixed with clove oil to form a smooth paste. A small amount of the paste is spread on a slide and, to thin the paste sufficiently, more clove oil is added.

This method is based on the fact that 1 mg of *Lycopodium* spores contains 94,000 spores; by counting both the spores and the pellets, the number of pellets in one gram of bran can easily be calculated according to the following equation:

$$E = \frac{e \times 94{,}000 \times L}{l \times 10}$$

where E = number of excreta pellets in 1 g of whole bran
e = number of excreta pellets found in a microscopic count
L = mg of *Lycopodium* spores used
l = number of *Lycopodium* spores found in a microscopic count

Reproducibility of results

In order to test the accuracy of this method, 10 samples were taken from the paste and for each sample spore and pellet counts in 10 microscopic fields were made.

It appeared that 10 counts from one sample were not sufficient, since deviation from the mean ran as high as 19%. However, where 10 samples (involving 100 fields) were analyzed, deviation was only 6%. To reduce deviation to 3%, 40 samples would be required. It was found that, for all practical purposes, 10 samples provide sufficient accuracy.

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STUDIES OF THE EFFECT OF SALINE IRRIGATION WATER ON CALCAREOUS SOILS. I. PERMEABILITY CHARACTERISTICS AND ADSORPTION OF SODIUM

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ABSTRACT

Long time permeability tests were carried out on strongly calcareous soils. Water of different salinity and distilled water were used alternatingly. Characteristic permeability curves were obtained and chemical changes were followed by analyzing the percolate and the soil.

The dynamic nature of the observed permeability trends was explained in terms of swelling, disaggregation and other factors affecting the nature of porosity available to flow.

Contrary to general assumption the great amounts of $CaCO_3$ present in the investigated soils did not contribute sufficient amounts of calcium ions to the soil solution to prevent the normal exchange reaction between the dissolved ions of the percolating saline water and the exchangeable bases of the clay mineral complex. The adsorption of sodium ions manifested itself by the swelling of the soil and by a sharp drop in its permeability. This became especially evident when the free salts were leached out by distilled water, a treatment that is considered equivalent to the effect of winter rains. Subsequent application of saline water to the still wet soil did not restore the initial good permeability, unless the swelled and dispersed clay again became aggregated. A change to suitable irrigation water is not sufficient to reaggregate the soil; on the other hand, the process is aided by the drying of the soil.

It is suggested that gypsum be applied regularly as a preventive soil conditioner on all soils where permanent irrigation with more or less saline water, and containing sodium salts, is established.

INTRODUCTION

With continuous application of saline water for irrigation purposes, the chemical and physical properties and hence the fertility status of the soil may become markedly affected.

In Israel, natural waters, especially underground waters, are in many cases extremely saline (Water commissioner 1948, Yaron 1952). The adverse effects on soils and soil fertility have been reported by several workers (Reifenberg 1935a, 1935b; Puffeles 1939; Ravikovitch and Bidner 1937, 1940; Ravikovitch 1946), stressing mainly the total soluble salt and the chlorine content of the soil and the irrigation water as related to the injurious effects on the crops. The present work was prompted by the difficulties encountered in the management of the calcareous soils of 'Emeq Hayarden (Upper Jordan Valley), especially in the heavily irrigated banana groves.

Various phases of the saline-water soil relationship have been studied; in the few instances where the chemical and physical effects were considered in relation to each other, it

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was, however, with respect to lime-free soils only (Fireman and Bodman 1940, Hallgren 1944, Cassidy 1944). Calcareous soils were believed to be able to supply sufficient calcium ions to the soil solution, and not to become adversely affected by saline irrigation water. In the present study laboratory experiments were carried out to clarify the mechanism of physical and chemical changes taking place in calcareous soils when they are irrigated with saline waters and to study the interaction between the various factors.

DESCRIPTION OF SOILS

The calcareous soils of 'Emeq Hayarden are formed on eroded deposits of a diluvial marl, locally called Lisan Marl, the upper strata of which are intermixed with alluvium washed down from the basalt hills (Reifenberg 1947, Yaalon 1954b). Their normal lime content is 25—50%, varying only little with depth. Clay comprises about half of the lime-free minerals, while the amount of coarse sand and humus is negligible. Texturally they are medium to heavy loams. The amount of soluble salts is negligible. Normally the water regime is good, the depth of the water table being well below the root zone throughout the year.

Irrigated agriculture is practised extensively in the area, the main water sources being the Jordan and Yarmuk rivers. The salinity of the Jordan upon leaving Lake Kinneret reaches up to 700 ppm or about 10 me/l, 60—70% of which is sodium, while the Yarmuk is considerably less saline. Banana groves are irrigated with up to 5000 m^3 per dunam per season. Various symptoms of decreased fertility have been observed and investigations of some of the factors affecting the status of the soils and crops were initiated (Stoler et al. 1952).

For the present laboratory study, a representative soil profile was chosen from a field in Zemach which, though cultivated, had not been irrigated for at least a generation. Three pits about 50—100 m apart were dug and the profile sampled. The morphological description is as follows:

Surface horizon	
0— 25 cm	The furrow slice; a greyish brown loam, the darkest layer in the profile. Root remnants, organic litter and dead seeds abundant. Well developed crumb structure; porous with many cavities and worm holes.
25— 45 cm	Grey-brown, lighter than upper layer. Fairly compact, but with many cavities. When crushed, forms very fine aggregates. Plant roots common.
Subsoil	Lime concretions noticeable.
45— 70 cm	Light gray. Fairly compact; structure indistinct, but when removed breaks down readily into fine aggregates. Plant roots and worm holes less common. Horizon boundaries are diffuse.
70—100 cm	Pale gray, white lime concretions distinguishable. Aggregates commonly coated white. Plant roots and larger cavities scarce, but pinholes common. Rather compact; structure indistinct, when crushed breaks down into irregular blocks.
> 100 cm	Very pale grayish colour, with numerous white lime concretions. Fairly compact and hard; breaks down to platy structure.

The soil was air dried and sieved through a 2 mm sieve which eliminated all visible plant remnants. Results of chemical and physical analyses are given in Tables Ia, Ib and Ic.

The clay fraction was subjected to X-ray examination and gave evidence of montmorillonite and illite minerals, some kaolinite and little quartz, in agreement with the

TABLE Ia

Mechanical composition

Depth (*cm*)		*Particle size distribution* 2000—200μ %	200—20μ %	20—2μ %	<2μ %	$CaCO_3$ %
0— 25	A*	2.1	35.7	24.2	38.0	
	B	0.9	14.8	9.8	37.0	37.5
	C	3.2	55.8	38.4	2.6	
25— 45	A	2.6	29.4	29.0	39.0	
	B	1.4	12.7	10.5	35.1	40.3
	C	3.0	41.5	45.8	9.7	
70—100	A	2.7	29.9	25.5	41.9	
	B	1.0	10.4	8.3	32.8	47.5
	C	3.6	41.0	36.2	19.2	
>100	A	1.2	32.4	32.4	43.0	
	B	0.6	10.6	10.1	33.2	45.5
	C	1.4	28.1	49.0	21.5	

*A — Particle size distribution of the total soil, including carbonates.
B — Acid treated soil; particle size distribution of carbonate free minerals.
C — Particle size distribution of the calcareous material; calculated from C = (A—B)·100 / $CaCO_3$.

TABLE Ib

Moisture and porosity

Depth (*cm*)	*Volume weight* *	*Porosity*** %	*Field capacity** %	*Available moisture**** (*volume* %)	*Air dry moisture* %
0— 25	1.25	53.5	29.6	19	5.6
25— 45	1.26	53.5	27.6	17	5.8
45— 70	1.23	54.5	26.1	15	5.8
70—100	1.21	55.0	25.9	14	5.2
> 100	1.15	57.0	26.2	14	5.3

* Field determination.
** Calculated from volume weight and specific gravity (taken as 2.70).
*** Difference between field capacity and wilting percentage, calculated on volume basis. The wilting percentage of the soil is 14.2±0.7%. Total available water down to a depth of 1 m is 160 mm (160 m^3 per dunam).

TABLE Ic

Chemical characteristics

Depth (*cm*)	*Cation exchange capacity* (*m.e./100 g*)	*Exchangeable cations* *Na* (%)	*K* (%)	*Ca+Mg* (%)	*Soluble salts** *EC.* 10^3 (25°)	*pH**
0— 25	27.2	4.6	6.8	88.6	1.28	7.50
25— 45	26.9	6.7	3.1	90.2	0.86	7.70
70—100	22.6	5.6	2.5	91.9	0.96	7.90
> 100	22.8	6.4	2.3	91.7	1.43	8.00

* 1:1 water extract. The electrical conductivity value is approximately equivalent to 1 me/100g soil. The amount of soluble Na was found to be 0.1—0.2 me/100 g, and the amount of Cl even less. The greatest part of the soluble salts hails therefore from dissolved $CaCO_3$.

high cation exchange capacity. The coarse fractions of the sand contained fragments of basalt and its weathering products, bearing evidence of alluvial admixture from basaltic rocks.

METHODS

A number of long time percolation experiments were carried out using irrigation water of different salt compositions as the percolating fluid. To simulate winter field conditions, this percolating fluid was changed during the experiment, and distilled water was substituted. Finally saline water was applied again. Characteristic time-permeability curves were obtained and the chemical interactions of the saline water with the soil were followed from regular analyses of the percolated liquid. At the end of the runs the soil was analyzed.

The experimental setup is shown in Figure 1. A weighed amount of air dry soil was poured into the permeameter through a wide mouthed funnel, enabling even distribution of the soil without a sorting process. The soil in the tube was then settled to a uniform density by dropping the tube ten times from a height to 2—3 cm onto a wooden block. The height of the soil column was carefully measured and recorded. To avoid disturbing the soil mass during wetting, coarse filter paper or a small cork disc was dropped on the surface to cushion the effect of the falling water.

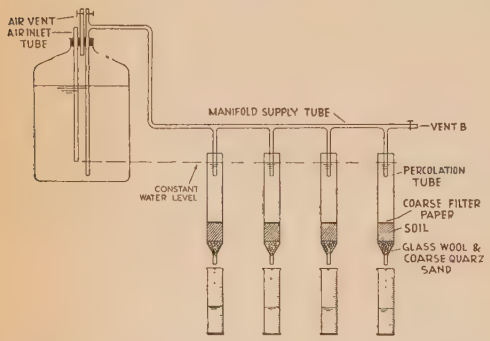

Figure 1
Experimental assembly for permeability studies. Height of soil column approx. 7 cm, area of cross-section 11.3 cm².

The flow of water was started by applying suction to the vent B (the supply tubes have to be clamped). Constant water level was maintained by the air inlet tube in the supply bottle. The percolated water was collected in graduated vessels and its amount recorded at suitable intervals.

When the composition of the applied water had to be changed, the supply was interrupted and the remaining water allowed to percolate. Final draining before changing the water supply was aided by applying suction to the outlet of the percolation tube.

To prevent fungal growth and microbiological activity, toluene was introduced from time to time into the percolating solution.

The percolated water was analyzed for its significant constituents. Total soluble salts were determined by evaporation of an aliquot or in some instances by electrical conductance. *p*H was measured electrometrically. Calcium was determined by the standard oxalate method or alternatively by the more convenient versenate titration, and at low concentration by flame photometry, using the EEL flame photometer with a suitable filter. Sodium and potassium were in all cases determined flame photometrically.

Chloride was determined by $AgNO_3$ titration, using potassium chromate as indicator. Bicarbonate was titrated in the same aliquot, with methyl orange as indicator.

At the end of the percolation test the soil was taken out from the tubes, air dried and analyzed for exchangeable bases and lime. Cation exchange capacity was determined by leaching with normal neutral NH_4-acetate solution and determining the adsorbed ammonia directly from the soil by distillation. Extractable sodium and potassium were determined in the leachate. Soluble salts were deducted, and exchangeable Ca + Mg obtained by difference.

Total lime was determined by the method of Passon. Mechanical analysis was carried out by the pipette method, both with and without the removal of lime. A preliminary study proved the sodium poly-meta-phosphate (Calgon) to be the best dispersing agent. The distribution of $CaCO_3$ among the various size fractions was obtained as a difference between the two methods (Yaalon 1954b).

RESULTS

The percolation rate was determined several times daily and the percolated liquid was collected and analyzed at suitable intervals. The results of characteristic permeability runs are presented in Figures 2—7. Each curve represents average data from four percolation tubes. Intrinsic permeability, k_i, is expressed in $m\mu^2$ units (Richards 1952). Total salt concentration in the percolate is expressed in ppm, and the concentration of the various ions in m.e. per litre.

In order to enable better comparison, the permeability trends for all treatments are presented again in Figure 8. The effect of the various treatments on the suite of exchangeable ions, as determined by soil analyses, is shown in Table II.

TABLE II

Effect of saline water on the suite of exchangeable cations

Run No.	*Soil and treatment*	*Exchangeable cations — me / 100 g*				*Equivalent Na-percentage*	*pH*
		Na	*K*	*Ca+Mg*	*Total*		
1	Surface soil (0—25 cm), water A*						
	Before	1.26	2.49	23.4	27.2	4.6	7.5
	After	2.07	1.22	20.7	24.0	8.6	7.5
2	Subsoil (>100 cm), water A						
	Before	1.47	0.52	20.8	22.8	6.4	8.0
	After	2.66	0.57	19.4	22.6	11.8	8.1
3	Subsoil (>100 cm), water B						
	Before	1.47	0.52	20.8	22.8	6.4	8.0
	After	3.30	0.47	19.1	22.9	14.4	8.1
4	Surface soil (25—45 cm), $CaCl_2$-water						
	Before	1.79	0.82	24.3	26.9	6.7	7.7
	After	0.89	0.63	25.6	27.0	3.3	7.5
5	Surface soil (25—45 cm), NaCl-water						
	Before	1.79	0.82	24.3	26.9	6.7	7.7
	After	7.09	0.78	19.0	26.9	26.3	8.3
6	Surface soil (25—45 cm), distilled water						
	Before	1.79	0.82	24.3	26.9	6.7	7.7
	After	0.96	0.88	25.7	27.6	3.5	7.6

* Salt concentrations in applied waters (in me/l) : Water A : Total conc. 12, Ca 2, Mg 2, Na 8, Cl 6, SO_4 2, HCO_3 4; Water B : Total conc. 24, Ca 4, Mg 4, Na 16, Cl 9, SO_4 9, HCO_3 6; $CaCl_2$-water: Ca 25, Cl 25; NaCl-water: Na 25, Cl 25.

PERMEABILITY TRENDS

The initial fluctuations

Permeability tests in the laboratory, whether on disturbed or undisturbed samples, bear evidence of the dynamic nature of porosity in soils. In all records, however, some common and characteristic trends can be distinguished (Pillsbury and Appleman 1945, Christiansen 1947, Greacen and Huon 1953).

In all runs discussed here, the initial decrease, due to swelling, was of short duration only, in some cases too short to become evident on the graphs. The second phase increase, due to dissolution of entrapped air, was of longer duration, the attained maximum being strongly dependent on the quality of the applied water. Only in a limited number of cases was there a marked dissolution of entrapped air at the beginning of the second and third stage of the runs, thus bearing evidence to the considerable effect of antecedent moisture on the initial permeability rates.

The long time decreases

A decrease in permeability under field conditions is generally associated with defective structure, either through compaction of the soil or due to the dispersion of its aggregates. The effect of sodium ions on the swelling and the dispersion of clay is well known; another significant factor affecting the cohesiveness of soil crumbs is the inherent swelling of the clay minerals. As swelling water is held too tightly to contribute to flow, the greater the swelling the lower the permeability. Greacen and Huon (1953) have recently presented conclusive evidence that the swelling of aggregates, and in extreme cases their general collapse with a resulting destruction of the pore system, is the main cause of the observed decreases in permeability during long time permeability tests. Using a micropermeameter and a photographic arrangement, they were able to observe directly the swelling and gradual distintegration of the aggregates.

The gradual continuous decrease in permeability observed in all runs of the presented results can be entirely attributed to the swelling of the soil and its effect on aggregation. Varying the composition of the applied water and changing the percolating water during the tests makes possible an interpretation of the effect of the chemical environment.

The aggregates of the surface soil, which hold 14.1% of monovalent exchangeable ions (Na+K), were rather unstable in distilled water, as is evident by the low level of the attained permeability. When NaCl-water was applied, extreme swelling was prevented as long as saline water was used, and the permeability attained a moderately high level. Where $CaCl_2$-water or mixed saline solutions were used, the permeability reached and remained at a much higher level.

Leaching of the soluble salts in the second stage of the runs resulted in a strong swelling and disintegration of the aggregates, thus decreasing the effective porosity available to flow. Where NaCl-water was previously applied, the collapse and dispersion of the aggregates resulted in a complete clogging of all pores. The decrease in permeability upon leaching of the soluble salts with distilled water was extremely rapid, especially where Na-containing water was previously used.

The permeability trends show clearly that the high content of lime which is present in these soils, despite its practically unlimited potential capacity to supply calcium ions, was unable to prevent the swelling and dispersion of the soil, which was caused

by the adsorption of sodium from the soil solution. The subsequent analyses of the soil bear evidence of considerable Na-adsorption (Table II). In the NaCl-series sodium adsorption and the associated swelling and dispersion of the clay was so strong, that the soil became completely clogged and impermeable, in spite of the fact that it still contained considerable amounts of soluble salts. Qualitative tests of swelling and dispersion were in excellent agreement with Na-adsorption data.

The nature of the effect of sodium salts on swelling and dispersion of clay with a resulting marked decrease in permeability becomes evident when the data are plotted as a function of the amount of percolated liquid, expressing the amount of percolate — in analogy with precipitation data — in mm water column. The relation is thus independent of time, while the reactions which can be assumed to be primarily dependent on the composition and amount of liquid become more clearly evident. When plotted on a logarithmic scale (Figure 9), a practically straight line relationship is obtained. Before becoming asymptotic to the abscissa, the decrease in permeability is over a wide range of values a logarithmic function of leaching with electrolyte-free water and the averse physical properties resulting from this treatment.

The rate of the decrease and the final level of the permeability values is clearly dependent on the previous history of the soil. Assuming that the percolated quantity in the laboratory experiment has a general relationship to field conditions, it can be seen that, where NaCl-irrigation was initially applied, the field soil would have become completely impermeable after only a few mm rain. After some 500 mm of winter rain the permeability of the $CaCl_2$-treated fields would be 4 times as good as the permeability of fields not irrigated with saline water. Thus, evidence is given of the slower dispersion and disintegration of the aggregates subsequent to a treatment with divalent calcium. A considerable decrease in infiltration rates of rain water at the end of the winter season was indeed also observed under field conditions.

The graphs bear evidence of two additional significant effects. Drying of the soil appears to have a significant beneficial effect on permeability. Before changing the composition of the irrigation water between the different stages of the run, draining of the applied water was aided by suction at the outlet. The passing air thus effected a certain degree of drying of the soil, although the soil moisture content was probably not reduced greatly below field capacity. Standing and partial drying of the soil in an environment of saline soil solution considerably enhanced the swelling and disintegration of the aggregates, as is evidenced by the much lower initial permeability in the second stage (distilled water) of each run. On the other hand, where soluble salts were leached out by distilled water, the partial drying of the soil resulted in a significant shrinkage of the swelled colloids with a consequently improved permeability in the third stage of the tests (saline water). Similar observations have been reported by Reitemeier et al. (1948) and have also been observed in the field.

Of greater significance is the observed effect that, when permeability decreased as a result of leaching with distilled water, the initial good permeability could not be restored simply by applying saline water. This is evident from the third stage of the permeability runs, when, in spite of the initial effect of drying, the permeability soon decreased again and remained practically constant during the run. $CaCl_2$-irrigation water was applied to the impermeable NaCl-treated soil, but permeability could not be restored. It is evident that the restoration of good permeability is not a reversible process, simply to be achieved

by a change in the composition of irrigation water. Increased electrolyte content will cause the flocculation of a dispersed clay, but will not cause its immediate aggregation. It appears that in the present study the colloids remained — except in the NaCl-treated soil — in a flocculated but cohesionless state, i.e. disaggregated (Gardner 1945). In the NaCl-treated sample the subsequently applied saline water was even ineffective in flocculating the dispersed soil, presumably due to insufficient access to the swelled colloids.

CHEMICAL EFFECTS

Total salinity

It is evident from the graphs that total salt concentration of the percolates bears no relation to permeability values. Upon application of saline water the total salt concentration and the concentration of the anions soon reached a constant value, which is directly related to the concentration of the applied water, but not to the permeability of the soil. As no significant absorption of anions is known to take place, the attained concentration remains constant as long as saline water is applied.

p*H*

The *p*H of the applied saline water and of the leachate was determined regularly. The values ranged generally between *p*H 7.0 — 8.0, with no definite trend. As the CO_2 content of the laboratory atmosphere was not controlled, no significance is given to values below *p*H 8.3 (Yaalon 1954c). Only in one case, distilled water after NaCl, did the *p*H rise considerably above this range, bearing evidence of Na_2CO_3 formation. This is confirmed by the analysis of the soil, which shows a significant increase in *p*H. No significant differences were observed in the other samples.

Chloride and bicarbonate concentration

During leaching with distilled water the decrease in the anion concentration was very rapid. Chlorides were completely leached out within a short time, while the leaching effect was somewhat slower with respect to bicarbonate. The final HCO_3 concentration was in all cases low, in agreement with the neutral or slightly alkaline reaction, and bearing evidence of only negligible dissolution of $CaCO_3$.

Mechanical composition

Lime content and mechanical composition were also determined on the treated soils, but no significant differences were observed.

Rate of leaching

In order to eliminate the great differences in permeability levels, the rate of leaching is also plotted as a function of percolated quantity of liquid, expressed in mm water column.

The total salt concentration relationships are shown for three runs in Figure 10. Here again two distinct phases seem to be distinguishable. An initial logarithmic decrease is followed by an asymptotical phase. The rate of the logarithmic decrease appears to be independent of the pretreatment, while the limiting value of the asymptote is related to the solubility of the soil minerals at the conditions of the experiment.

PERMEABILITY CHARACTERISTICS AND CONCENTRATION OF PERCOLATE

Saline water composition:

A (me/l)—Total conc. 12, Ca 2.0, Mg 2.0, Na 8.0, Cl 6.0, SO_4 2.0, HCO_3 4.0, Equiv. Na % 66.7

B (me/l)—Total conc. 24.0, Ca 4.0, Mg 4.0, Na 16.0, Cl 9.0, SO_4 9.0, HCO_3 6.0, Equiv. Na % 66.7

C (me/l)—Ca 25.0, Cl 25.0

D (me/l)— Na 25.0, Cl 25.0

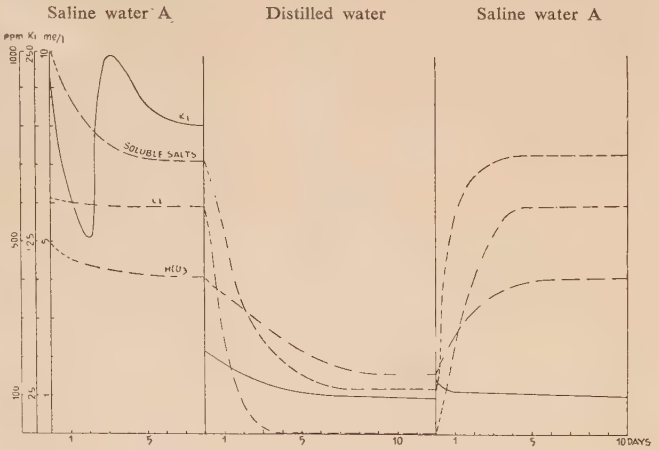

Figure 2 — Surface soil (0—25 cm)

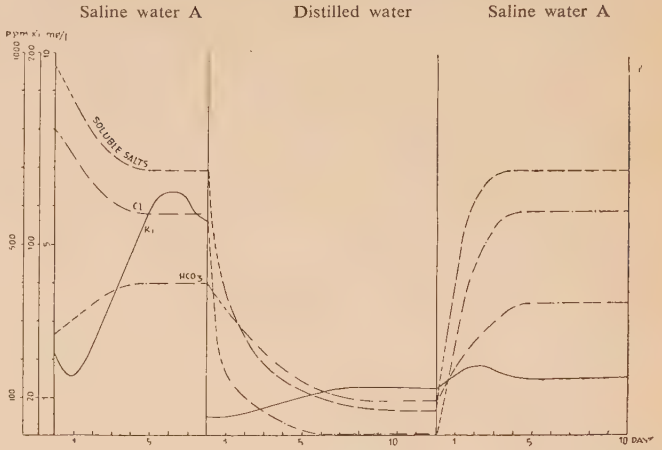

Figure 3 — Subsoil (> 100 cm)

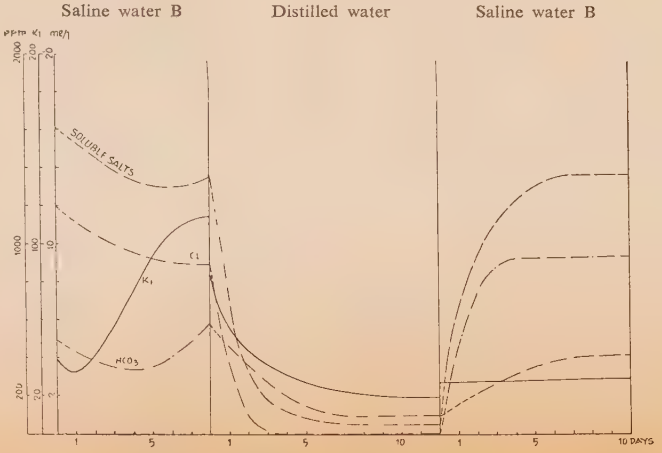

Figure 4 — Subsoil (> 100 cm)

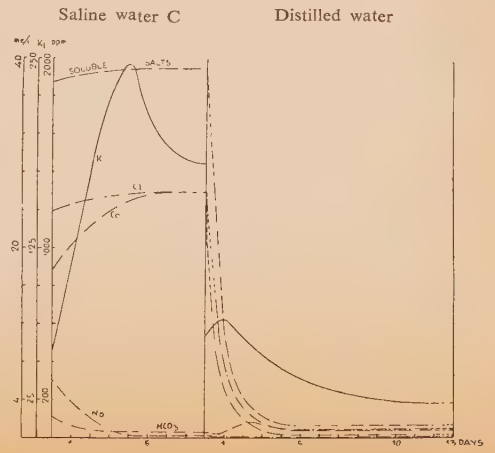

Figure 5 — Surface soil (25—45 cm)

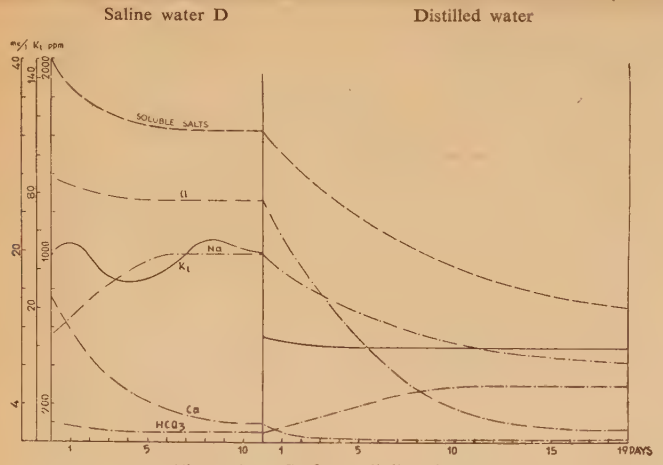

Figure 6 — Surface soil (25—45 cm)

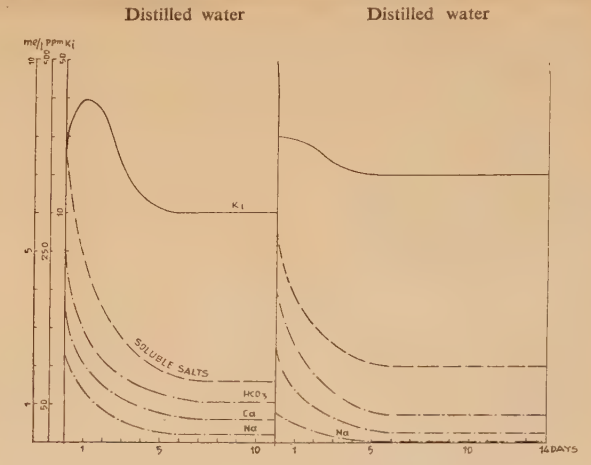

Figure 7 — Surface soil (25—45 cm)

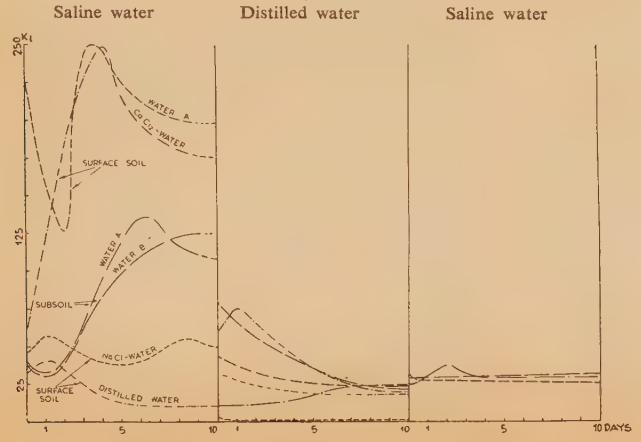

Figure 8
Summary of all treatments. Permeability characteristics as a function of time and saline water application.

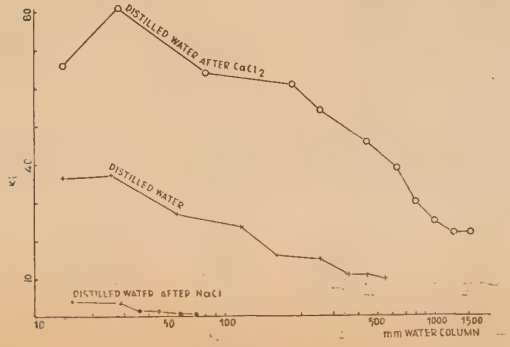

Figure 9
Permeability as a function of the amount of percolate. Leaching of salts with distilled water.

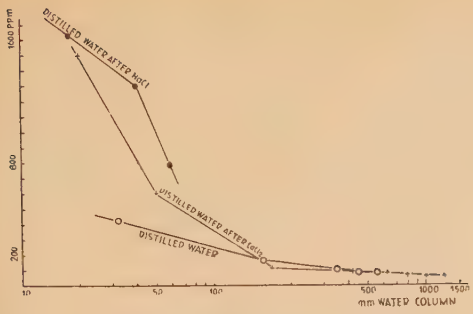

Figure 10
Leaching of salts with distilled water.

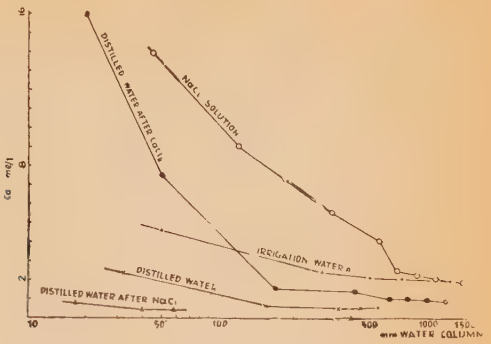

Figure 11
Concentration of calcium in the percolate as a function of the leaching volume.

The behaviour of calcium during percolation can be followed from Figure 11. The five graphs represent widely different treatments, demonstrating the rate of replacement, leaching and dissolution. The upper curve shows the Ca concentration in the leachate during application of NaCl-water, and hence represents in its initial phase the rate of replacement and exchange between Ca and Na, while its limiting value is determined by the rate of dissolution of $CaCO_3$ in the saline solution. The rate of Ca replacement by a mixed saline solution, containing a small amount of calcium, is represented by irrigation water A. The equilibrium value attained here equals the calcium concentration of the applied water, bearing evidence that only negligible amounts of $CaCO_3$ went into solution under these conditions.

The $CaCl_2$-curve bears evidence of the high leaching rate of the free salt; the excess of salt having been leached, the limiting value designates the solubility of $CaCO_3$. The remaining two graphs show the rate of dissolution of $CaCO_3$ under conditions of leaching. The limiting values of $CaCO_3$ solubility attained in these examples, as in all other cases, are a function of the environmental conditions, and will be discussed in greater detail in another paper.

The displacement and leaching of potassium in the present experiment have been very moderate. It appears that at very low saturation the exchangeability of potassium decreases considerably, possibly approaching a certain limit value for any specific environment. Such a concept is well in agreement with the theory of the effect of complementary ions on the ease of cation exchange reactions (Jenny and Ayres 1939, Wiklander and Gieseking 1948). A gradual, slow release of lattice bound potassium into the exchangeable form may be a contributing factor.

Adsorption of sodium

From Table II it can be seen that, in all treatments where sodium-containing water was used, the amount of exchangeable sodium increased considerably. In runs No. 1 and 2, where the moderately saline water A was used, the increase in exchangeable Na-percentage was 87% and 84% respectively, with the stronger water B it was 125%. When exclusively NaCl-water was applied, the increase was almost 300% and reached a value of exchangeable Na-percentage which is generally considered highly toxic for all agricultural plants. On the other hand, when Na-free water was used, as in runs 4 and 6, the exchangeable Na-percentage decreased by about 50%.

When considering the figures of Table II it must be remembered that the various treatments involve an application of somewhat different amounts of saline waters, and also include a leaching with distilled water. Therefore the data cannot be compared directly with each other. Based on a calculation of the amount of saline water applied, the data indicate that, where the mixed salt solutions containing 66.7 equivalent percent of sodium were used, 4—6% of the total applied sodium was adsorbed. From the single-salt NaCl solution 15—20% of the total amount of sodium was adsorbed by the clay.

Evidently the presence of $CaCO_3$ was not able to prevent the adsorption of sodium from the soil solution whenever this ion was present in the percolating liquid.

DISCUSSION

Mechanism of the long time decrease in permeability

The results demonstrate that permeability characteristics in calcareous soils are sensitive to the quality of irrigation water, and that such soils may become completely water-logged when, subsequent to unsuitable Na-containing water, the salts are leached out by an application of electrolyte-free water.

The mechanism of the gradual and continuous changes in permeability can be explained in the following way.

The strongly sorbed and oriented swelling water must be considered as not contributing to the fluid flow during percolation. It thus reduces the effective porosity available to flow and disrupts the continuity of many pores. Short and narrow flow channels may become completely clogged, others isolated. The liquid is forced to change its flow paths, which thus become longer and more tortuous.

The degree of swelling is known to be a function of the type of clay mineral and its exchangeable cations. It is therefore to be expected that permeability trends will be sensitive to the variable factor, i.e. the quality of irrigation water. The initial high rate of swelling may be attributed to the inherent property of the clay mineral type. On the other hand, the continuous exchange reactions taking place during percolation will control the degree of swelling under each particular chemical environment.

As the stability of aggregates is greatly reduced by the continuous exchange processes, a gradual disintegration of the aggregates, resulting in an additional clogging of pores, will take place. In extreme cases of high sodium saturation a deflocculation will follow after a complete collapse of the aggregates, and the dispersed particles may clog all conducting pores entirely.

Aggregation not being a simple reversible process, the application of suitable irrigation water to a dispersed or disaggregated soil will not produce an immediate improvement. Considerable improvement is to be expected only when granulation and aggregation is again achieved, e.g. by drying and wetting cycles.

Cation exchange reactions during percolation

The presented data provide evidence that normal exchange reactions between the percolating liquid and the clay complex have taken place, resulting in a gradual saturation with sodium, whenever this ion was present in the leaching solution.

The laws of ion exchange have been established from equilibrium experiments. In permeability experiments, or in the field, the conditions are different insofar as the leaching solution is constantly or periodically renewed. A greater amount of electrolyte

thus comes into contact with the soil and a much higher saturation is reached even with relatively dilute solutions. In general the adsorption of sodium will increase as its concentration in the leaching solution increases; and, if half or more of the cations are sodium, appreciable amounts will be adsorbed by the clay. Since already a rather low sodium saturation of the exchange complex affects the physical properties of soils, and consequently plant growth, prolonged use of even low sodium water may saturate the exchange complex to an undesirable level.

The amount of Na retained by the soil under field conditions is not easily predictable. It depends largely on the prevalent irrigation practice and drainage; however, it can be roughly estimated from a calculation of the yearly salt balance of a certain area. Under the heavy irrigation practice used in 'Emeq Hayarden, an amount just below 0.1 symmetry concentration* of Na is added to the root zone per season. Thus, if not prevented from being adsorbed and not removed from this zone by leaching or plant uptake, it would soon accumulate in quantities sufficiently large to limit the fertility of the soil.

Effect of slightly soluble salts

In spite of the very low solubility of $CaCO_3$, it was widely believed that it contributes significant amounts of Ca ions to the soil solution and represses the adsorption of sodium (Eaton and Sokoloff 1935, Kelley et al. 1940, Fireman and Magistad 1945).

The ineffectiveness of $CaCO_3$ in preventing adsorption of sodium during percolation has been demonstrated in the experimental part of this work. Based on equilibrium experiments, this was recently also shown by Bidner-Bar Hava and Ravikovitch (1952), who demonstrated that $CaCO_3$ was effective in preventing Na-adsorption in dilute solutions only. The effect of $CaSO_4$ was considerably stronger and remained effective also at higher concentrations of the applied solutions.

An examination of solubility data of $CaCO_3$ and the various factors affecting it leads to the conclusion that, even at the relatively high carbon dioxide concentration likely to occur in the soil atmosphere and at the normal ionic strength of the soil solution, solid $CaCO_3$ would be able to supply only 2—5 me of Ca-ions per litre (Yaalon 1954a). If due to the presence of Na-clay the *p*H rises above 8.0, and carbon dioxide pressure is decreased as a result of reduced permeability and air exchange, then the solubility of $CaCO_3$ is considerably less than 2 me/l. If *p*H rises above the value of 8.3 the possibility of Na_2CO_3 formation is acute.

The reported percolation experiments confirm these values. Where NaCl was used, the concentration of calcium in the percolate reached a state of equilibrium at 2.0 me/l. With distilled water the solubility reached only about 0.5 me/l, indicating a very low CO_2 content during percolation. The increase of 1.5 me/l in Ca-ion concentration when NaCl was used is well in agreement with the effect of ionic strength on solubility. In this case, however, the calcium ions are also brought into solution by displacement from the clay complex, thus reducing the amount of $CaCO_3$ that dissolves. The capacity of solid $CaCO_3$ to alter the composition of the liquid phase is therefore very limited.

On the other hand, $CaSO_4$ is able to supply to the soil solution about 30 me of Ca per litre, and can thus change markedly the undesirable proportions of Na/Ca in the liquid

* *Symmetry concentration* is the amount of ions in the solution phase in relation to the amount of exchangeable ions.

phase. These considerations lead, therefore, to the conclusion that, wherever saline water containing a considerable percentage of sodium is used, gypsum should be applied regularly as a preventive soil conditioner, either to the irrigation water or directly to the soil.

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RATES OF NITRIFICATION IN NATURAL AND "CONDITIONER"—FORMED SOIL AGGREGATES OF VARIOUS SIZES

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INTRODUCTION

Oxidation of nitrogen in soils is mainly a microbiological aerobic process; the rate of formation of nitrates is greatly dependent upon the structure and aeration of the soil in which it occurs. Nitrate nitrogen is considered the form of nitrogen most available to plants. Hence, it is obvious that the structure of a soil, by influencing the rates of nitrification, will also influence nitrogen availability to plants. The whole issue of the influence of soil structure upon plant nutrient availability was excellently reviewed by Page and Bodman (1951).

The newly developed soil conditioners of the krilium type enable us to improve the structure of naturally poorly aggregated soils (Bodman and Hagan 1952, Fuller and Gairaud 1954, Hedrick and Mowry 1952, Hagin and Bodman 1954). It therefore seems to be of interest to compare the nitrification rates in natural and in conditioner-formed aggregates, and thus to learn about the possible influence of conditioners upon the nitrogen availability in treated soils.

MATERIALS AND METHODS

Three soils were chosen for the experiment: (1) An alluvial heavy clay soil, containing 1.5% organic matter and 20% $CaCO_3$, from Mishmar Ha'emeq. (2) A heavy clay soil, typical for the red soils of the mountainous regions, rich in organic matter (4.2%) and free of $CaCO_3$, from Eilon. (3) A loess sandy loam soil typical for the Negev, poor in organic matter (0.46%) and containing 16% $CaCO_3$, from Gilat.

Five different aggregate sizes were prepared from each of the soils from Eilon and Mishmar Ha'emeq, by crushing the dry natural clods and sieving. The dry aggregate classes prepared were as follows: (1) 5—2 mm, (2) 2—1 mm, (3) 1—0.5 mm, (4) 0.5—0.25 mm, (5) <0.25 mm.

The soil from Gilat had only four sizes of dry aggregates; the largest (5—2 mm) was lacking, as the clods are naturally very unstable and it was impossible to obtain this size of aggregates.

Another batch of the three soils was crushed to pass a 2 mm sieve, and then mixed with Agrylon (a soil conditioner of the HPAN type — hydrolized polyacrylonitrile, produced by Serafon, Rehovot), at the rate of 2 g Agrylon per 1 kg soil, wetted and continuously mixed by spatula until relatively large aggregates (size of a few mm) were produced. The soil was air dried. The dried aggregates were crushed and sieved to give three aggregate classes: (1) 5—2 mm, (2) 2—1 mm and (3) 1—0.5 mm.

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Water stable aggregates were determined by wet sieving (Richards 1954), real specific gravity by the pycnometer method (Richards 1954), and apparent density by weighing a measured volume of the aggregates packed in a measuring cylinder. The moisture content at field capacity of the samples was determined as described elsewhere (Hagin 1952). Total pore space and non-capillary porosity — space occupied by air — were calculated from the above mentioned data. Nitrates were determined in water extracts by the phenol-disulfonic method (Snell and Snell 1949), and organic matter was determined by oxidation with potassium bichromate and texture by Beams' method (Wright 1939).

The prepared soil samples were each packed into glass vials, 50 g per vial, the height of the soil column being 10 cm. The samples were watered according to their water content at field capacity, loosely stoppered and placed in an incubator at 31°C. Three glass vials per treatment were withdrawn for analyses at three determined periods (two, four and eight weeks after preparation and water addition).

RESULTS

In the first stage of the work tests for organic matter, $CaCO_3$ and real specific gravity were made, in order to determine whether the crushing and sieving procedures did not introduce unwanted variations in the experimental material. No appreciable differences were detected, and therefore it was assumed that the only variable in the experiment was the size and nature of aggregates.

In Table I some of the characteristics of the different samples are given. It may be seen that variations in size of water stable aggregates, noncapillarity porosity and water content at "field capacity" are considerable.

In Figures 1, 2, 3 the rates of nitrification in the different aggregate classes are given. The curves were drawn according to averages of the three determinations per treatment, for each period of analysis. The differences between replicates and the mean did not exceed five percent. It is easily apparent that, in all three soils, the nitrification rates are much higher in the Agrylon treated samples than in the untreated ones of the same dry aggregates class. The two small size classes always have the lowest rates of nitrification.

Accumulation of ammonia was also measured in the same samples. In all coarse aggregated samples, only 2—3 p.p.m. of ammonia were detected. However, in the two finely aggregated samples (0.5—0.25 mm and <0.25 mm) more ammonia accumulated (40—50 p.p.m.).

DISCUSSION

The results expressed in Figures 1, 2, 3 show that the finely aggregated samples always showed lower rates of nitrification than the coarser ones. This is consistent with other work done in this field (Page and Bodman 1951). The three aggregate sizes which were prepared by addition of soil conditioner gave much higher nitrification rates than aggregates of the same size untreated.

The results in Figures 1—3 were classified according to the sizes of the dry aggregates. However, soil aggregates disintegrate more or less upon being wetted, the rate of disintegration being dependent on the previous crushing and the bonds which bind the

particles into aggregates. By making a water stable aggregates analysis and calculating the mean weight-diameter, a better index of aggregation of the soil preparates is obtained.

It is obvious from Figures 1—3 that accumulation of nitrates stops, or is very slow in most cases, after a period of eight weeks. It therefore seems justifiable to compare the nitrification rates after this period.

In Figures 4, 5, 6 the amount of nitrates accumulated after a period of eight weeks is plotted against the mean weight-diameter of the soil samples.

It seems from Figure 4 that there is a dependence of nitrate formation on the amount of water stable aggregates in the soil from Mishmar Ha'emeq. Samples having larger and more stable aggregates — the conditioner-treated samples — have accumulated more nitrates than the less aggregated, untreated samples, over the same period of time. But on closer examination of the same figure it may be seen that the class of 1—0.5 mm conditioner-treated aggregates has a high amount of nitrates, actually not less than the 5—2 mm class, although its mean weight-diameter of water stable aggregates is relatively low, and that it corresponds to that of the 2—1 mm aggregate untreated class. This last one, however, accumulated much less nitrates. It seems that the accumulation of nitrates in the conditioner-treated samples is not dependent upon their structure status.

Similar observations may be made in Figures 5 and 6, where the relation of nitrates accumulation over a period of eight weeks to the mean weight-diameter of aggregates is given for the samples from Eilon and Gilat.

Nitrate accumulation was correlated to another measurement of structure, namely to the noncapillary porosity, which in these experiments is assumed to be identical with the space occupied by air. The correlations are illustrated in Figures 7, 8, 9. They reveal a picture similar to that obtained previously.

In an attempt to clarify why the Agrylon-treated samples had high nitrification rates which were not related to the amount and water stability of aggregates, the apparent density of the aggregates themselves was measured. The measurements of pore spaces previously mentioned (Table I) were based on determination of apparent density for the samples as a whole, while here the apparent density of individual aggregates was measured. The determination was made as described by McIntyre and Stirk (1954), at two tensions. According to these authors, at a tension of 10 cm kerosene all pores larger than 0.14 mm are drained, and at 5 cm pores larger than 0.28 mm. It was assumed that at the higher tension all the interaggregate pores of the smaller aggregate samples were emptied, while for the larger ones the lower pressure sufficed. It seems that the results in Table II justify this assumption. Also, it is quite clear from this table that apparent densities of Agrylon-treated and natural aggregates are essentially the same, and it may be concluded that the relative volumes of intraaggregate spaces do not differ.

In the course of the work, the question arose whether Agrylon by itself might be a nitrogen source, and the high nitrification rates of the treated samples could thus be explained. However, judging by the data in the literature (Bodman and Hagan 1952, Mortensen and Martin 1954), and also from results of an experiment with pure sand, this explanation was rejected. In the above mentioned experiment, pure sand was mixed with

Agrylon, wetted and incubated in the same way as the soil samples. However, no nitrates were detected after incubation.

SUMMARY AND CONCLUSIONS

Nitrification rates in three Israeli soil types, where part of each sample was treated by a soil conditioner of HPAN type, Agrylon, and the other part was untreated, were measured.

The soil samples were prepared in various aggregate size classes.

It was found that the finely aggregated classes had lower nitrification rates than the coarsely aggregated ones. Also, the data offer some evidence that, in soils having water stable aggregates with relatively high mean weight diameter, nitrification is more or less independent of aggregation. Agrylon treated samples always had much higher nitrification rates than the untreated ones.

A possible conclusion from this work is that "conditioned" soils, through some mechanism, have accelerated rates of oxidation of complex nitrogen compounds into nitrates, thereby releasing larger amounts of nitrogen for immediate use of plants than the same untreated soils, and thus raise nitrogen availability in them.

TABLE I

Characteristics of the soil preparates

Origin of soil	*Conditioner treatment*	*Size of dry aggregates mm*	*Water stable aggregates*			*Total pore space*	*Water at field capacity*	*Noncapillary porosity*
			>2 mm %	*>0.25 mm* %	*Mean weight diameter*	%	%	%
Mishmar Ha'emeq	None	5—2	12.2	75.2	0.7	52.9	41.7	6.5
		2—1	9.6	75.7	0.6	52.8	41.9	5.9
		1—0.5	0.8	66.4	0.4	52.8	42.1	6.0
		0.5—0.25	0.0	36.8	0.2	53.2	44.4	4.4
		<0.25	0.0	0.9	0.1	51.0	43.6	0.0
	0.2% Agrylon	5—2	48.1	95.2	1.9	58.9	41.4	17.9
		2—1	25.1	88.8	1.3	55.2	41.6	11.5
		1—0.5	1.0	79.9	0.6	52.9	43.3	4.8
Eilon	None	5—2	59.9	91.5	2.1	53.1	28.0	22.0
		2—1	32.4	94.6	1.7	53.9	30.8	20.3
		1—0.5	0.9	87.8	0.6	54.3	33.5	18.1
		0.5—0.25	0.0	50.3	0.3	56.2	41.5	13.0
		<0.25	0.0	1.7	0.1	51.3	43.7	1.0
	0.2% Agrylon	5—2	39.5	91.9	1.8	57.0	31.5	24.9
		2—1	24.7	93.9	1.6	52.1	30.5	17.7
		1—0.5	0.2	89.8	0.7	51.3	34.5	11.6
Gilat	None	2—1	0.9	19.4	0.2	58.6	25.2	31.4
		1—0.5	0.0	15.5	0.05	59.0	23.2	34.2
		0.5—02.5	0.0	4.9	0.03	55.3	22.1	29.7
		<0.25	0.0	0.0	0.0	47.4	22.1	17.2
	0.2% Agrylon	5—2	97.3	98.5	3.2	57.0	14.2	41.1
		2—1	24.2	97.1	1.5	59.0	18.7	39.0
		1—0.5	0.0	93.9	0.5	60.0	21.1	38.1

TABLE II

Apparent density of aggregates

Origin of soil	*Size of dry aggregates mm*	*Apparent density*			
		At 10 cm tension		*At 5 cm tension*	
		Agrylon added	*Without Agrylon*	*Agrylon added*	*Without Agrylon*
Mishmar	5—2	1.94	1.97	1.96	1.91
Ha'emeq	2—1	1.97	1.88	1.97	1.90
	1—0.5	1.90	1.89	1.62	1.60
Eilon	5—2	1.93	1.94	1.97	1.94
	2—1	1.95	1.89	1.84	1.87
	1—0.5	1.97	1.99	1.38	1.47
Gilat	5—2	1.90	—	1.88	—
	2—1	1.88	1.86	1.67	1.60
	1—0.5	1.94	1.96	1.76	1.14

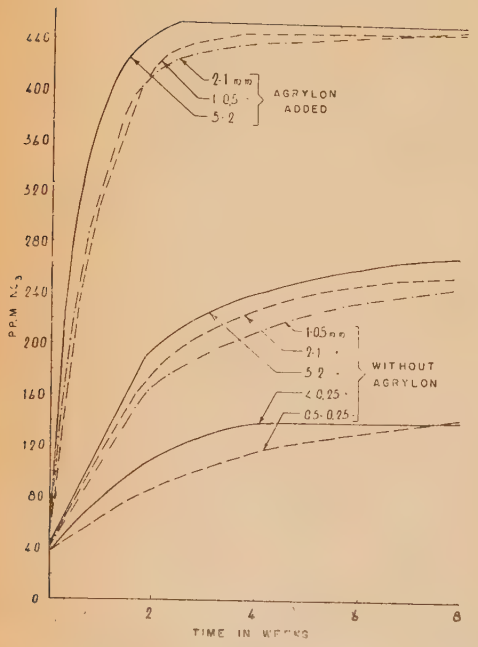

Figure 1

Changes in nitrate content of soil aggregates from Mishmar Ha'emeq.

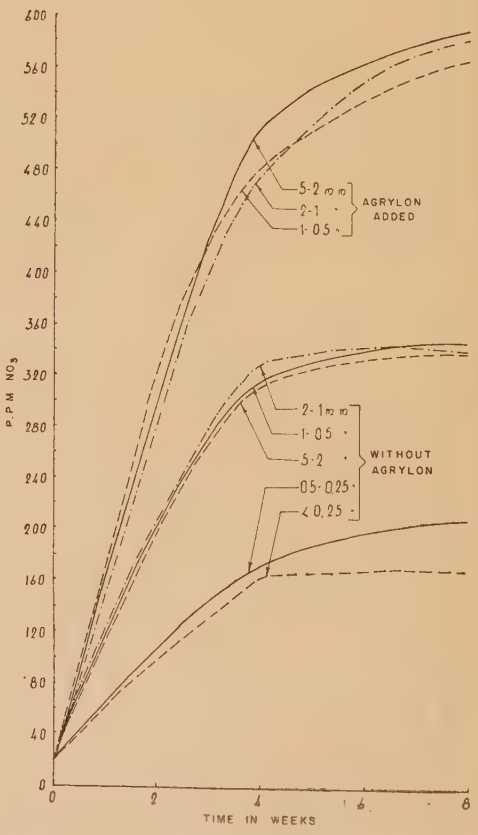

Figure 2

Changes in nitrate content of soil aggregates from Eilon.

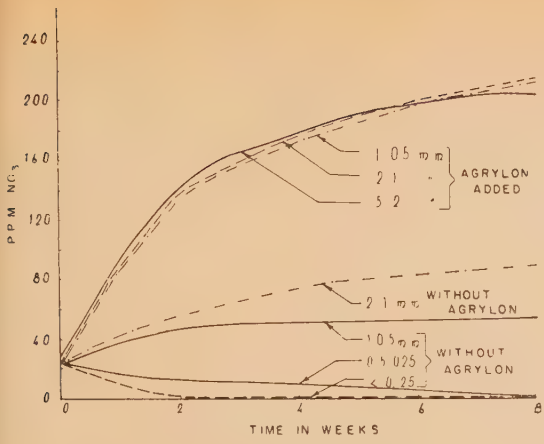

Figure 3
Changes in nitrate content of soil aggregates from Gilat.

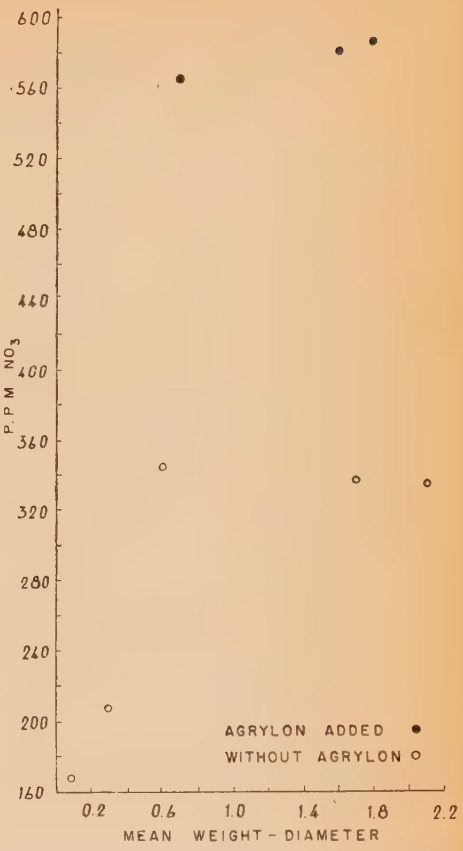

Figure 5
Correlation of nitrate accumulation over a period of eight weeks with the mean weight-diameter of water stable aggregates from Eilon.

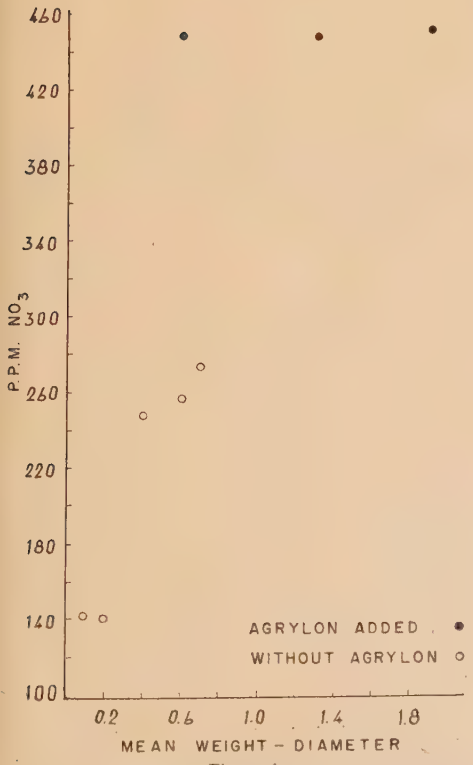

Figure 4
Correlation of nitrate accumulation over a period of eight weeks with the mean weight-diameter of water stable aggregates from Mishmar Ha'emeq.

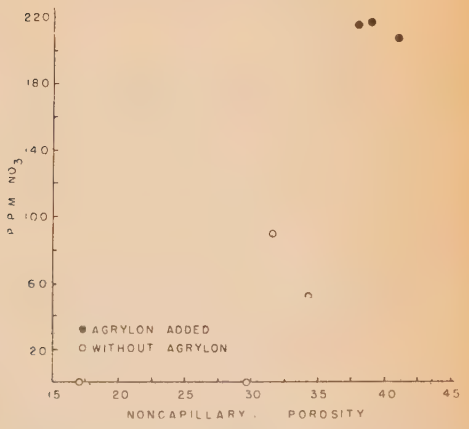

Figure 6
Correlation of nitrate accumulation over a period of eight weeks with the mean weight-diameter of water stable aggregates from Gilat.

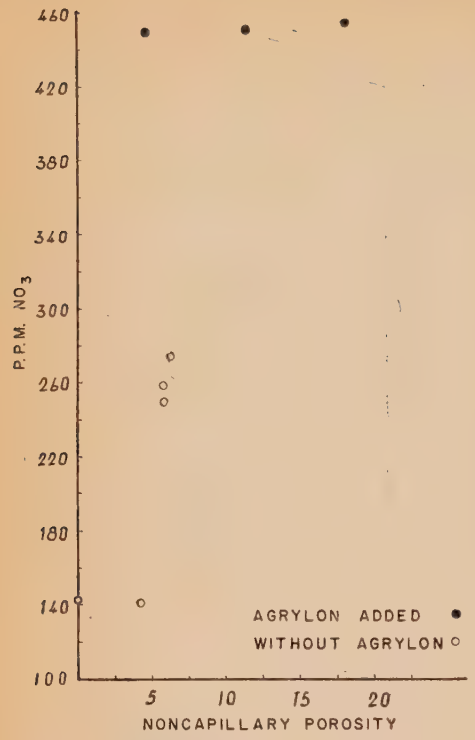

Figure 7
Correlation of nitrate accumulation over a period of eight weeks with the capillary porosity of samples from Mishmar Ha'emeq.

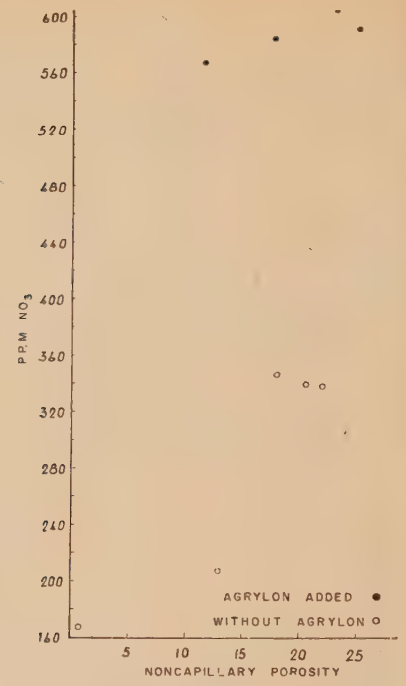

Figure 8
Correlation of nitrate accumulation over a period of eight weeks with the capillary porosity of samples from Eilon.

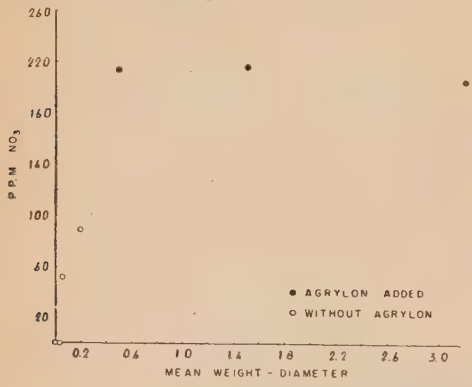

Figure 9
Correlation of nitrate accumulation over a period of eight weeks with the capillary porosity of samples from Gilat.

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MICROPALEONTOLOGY AND THE CRETACEOUS-TERTIARY BOUNDARY IN ISRAEL

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ABSTRACT

Observations on deposits of late Cretaceous and early Tertiary age in Israel and the Near East in general, especially micropaleontological ones, are discussed. On the basis of available evidence the Cretaceous-Tertiary boundary in Israel and the Near East must be placed at the boundary between the Maestrichtian and the Danian (i.e. at the boundary between the *Guembelina-Globotruncana-* and the *Globigerina*-zone). The value of the *Globigerina*-zone as evidence for a Cretaceous-Tertiary unconformity is stressed. The cause of this unconformity is probably to be found in epeirogenic (?synorogenic) movements at the end of the Cretaceous and at the beginning of the Tertiary. The junction between the *Globigerina-* and the *Globigerina-Globorotalia* (*Truncorotalia*)-zone is regarded for the time being as the Danian-Paleocene boundary. It seems desirable to create a new series (epoch) to include the Danian and the Paleocene, both belonging to the Tertiary.

The problem of determining the Cretaceous-Tertiary boundary involves two main points of discussion and disagreement: a. the position of this boundary [at the limit Maestrichtian-Danian or at the limit Danian-Paleocene and, therefore, the position of the Danian as such (Upper Cretaceous or Lower Tertiary)]; b. the continuity of sedimentation from the late Cretaceous into the early Tertiary in various places of the world.

The Cretaceous-Tertiary boundary in the Near East and its megapaleontological interpretation

Until a few years ago the age of deposits at the Cretaceous-Tertiary boundary in the Near East was highly controversial. Generally, the Cretaceous-Tertiary boundary was reported to be very unsharp, due to the — repeatedly emphasized — continuity of sedimentation from the Cretaceous into the Tertiary of this region, as well as to the insufficient megafaunistic characteristics which would facilitate the drawing of a definite boundary between the Danian (previously mostly regarded as belonging to the Upper Cretaceous) and the Paleocene (regarded as earliest Tertiary). The boundary between the Maestrichtian and the Danian, however, was believed to be much better defined megapaleontologically by the extinction of Ammonites, Belemnites, Rudists, *Inoceramus*, etc. The boundary between the Maestrichtian and the Danian has been traced in the Near East mostly above the strata carrying the last Ammonites. Rudists disappear in various regions of the Near East at various stages of the Upper Cretaceous. In Israel, for instance, they disappear at the end of the Turonian, in Syria, Lebanon,

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Egypt and Turkey in the Maestrichtian. Belemnites occur only sporadically and extremely rarely in this region. On the other hand, strata carrying *Inoceramus*, but which were devoid of Ammonites, were sometimes placed already in the Danian (e. g. in Israel) (see also below). The deposits between the upper limit of occurrence of Ammonites and the lower limit of deposits of unquestionable Ypresian age were assigned to the "Danian", "so-called Danian", "Dano-Montian" or — more generally — to the "Cretaceous-Tertiary transition series", "Passage-beds", "Cretaceous-Eocene transition", or "Senonian-Eocene transition". Since the most distinct faunal break was observed at — what was believed to be in the whole Near East — the Maestrichtian-Danian boundary (extinction of Ammonites) and since no clear megafaunistic criteria were known to facilitate the separation of the Paleocene from the Danian, it seemed, indeed, that the Cretaceous-Tertiary boundary in the Near East is megapaleontologically very difficult to trace, at least as long as one regards the Danian as belonging to the Upper Cretaceous.

The Cretaceous-Tertiary boundary in the Near East and its micropaleontological interpretation

Micropaleontologically, the Cretaceous-Tertiary boundary in the Near East seemed to be not easier to trace than megapaleontologically: "larger" Foraminifera were known to be mostly absent in deposits at the Cretaceous-Tertiary boundary in this region (except some scattered and rather rare occurrences of Orbitoids and Nummulites) and the "micro"-foraminiferal faunas were reported to be transitional from the highest Cretaceous into the early Tertiary.

Literature on the microfaunas of the deposits of late Cretaceous-early Tertiary age in the Near East dealt until recently mainly with "larger" Foraminifera; "small" Foraminifera have been greatly neglected. Nevertheless, the deposits at the Cretaceous-Tertiary boundary in this region were subdivided already more than 15 years ago into two zones*: a *Guembelina-Globotruncana* zone below and a *Globigerina-Globorotalia*** zone above (Henson 1938). Henson (op. cit.) states that the "transitional microfauna extends from the highest Danian . . . into the early Eocene" and that "as a general rule the junction between the *Globotruncana-Guembelina* and the *Globigerina-Globorotalia* faunas may be accepted . . . as a reasonable approximation of the Cretaceous-Eocene contact". From Henson's (op. cit.) publication it results that the "transitional microfauna" is that of the *Globigerina-Globorotalia* zone and, since Henson states that this transitional fauna extends "from the highest Danian", it follows that Henson placed the Cretaceous-Tertiary boundary at the limit between the Danian and the Paleocene (evidently included by him in the Eocene). It follows, furthermore, that Henson believed the *Guembelina-Globotruncana* fauna to characterize Danian deposits too, at least up to the "highest Danian". It must, however, be emphasized that at the time of Henson's publication it was believed by most authors that *Globotruncana* occurs

* The term "zone" is still controversial. If we adhere to Fiege's (1951) definition of this term, the latter cannot be properly applied to biostratigraphic units, characterized by certain assemblages or genera-associations, as the case is with the "zones" referred to here.

** Henson referred to sharply keeled *Globorotaliae* of the *simulatilis-velascoensis* group, therefore to *Truncorotaliae*. The same is true of Tromp's (see later) records.

also in the Danian (see e.g. Renz 1936, Glaessner 1936, et al., as well as Reichel's [1952] remarks).

Tromp (1949a) placed the top of the *Guembelina-Globotruncana* zone of the Near East in the Upper Cretaceous (top of Upper Senonian or top of Maestrichtian, *fide* Tromp) and the *Globigerina-Globorotalia* zone in the Lower Eocene (evidently including the Paleocene). Tromp placed, therefore, the Cretaceous-Tertiary boundary in the Near East at the junction between the *Guembelina-Globotruncana* and the *Globigerina-Globorotalia* zones (in agreement with Henson 1938), but at the top of the Maestrichtian. On the other hand, Tromp (op. cit.) reports the Cretaceous-Tertiary boundary in the Near East to "(cut) through the so-called Danian" and concludes, therefore, that the Danian as an accurate unit should be abolished altogether not only in the Near East, but perhaps in other regions, too. Tromp distinguished between Turonian and Lower Eocene three stratigraphic units only, and "tentatively" called them Santonian, Campanian and Maestrichtian. His conclusions have recently been rejected by Jeletzky (1951) and many micropaleontologists have not only succeeded in distinguishing between Maestrichtian and Lower Eocene both the Danian and the Paleocene, but also in subdividing the latter into substages (see e.g. Brotzen 1948).

Nakkady (1949, 1950) reports the microforaminiferal faunas of Egypt to be transitional from the late Cretaceous into the early Tertiary. The "transition beds" are subdivided by Nakkady into two zones: a *Guembelina-Globotruncana* zone below and a *Globigerina-Globorotalia* zone above.

LeRoy (1953) recognized two main subdivisions of the late Cretaceous-early Tertiary deposits at Maqfi (Egypt): strata with *Globotruncana* and *Guembelina* (Cretaceous) and above them, but separated from the latter by an unconformity, strata carrying *Globorotalia* (early Eocene, *fide* LeRoy).

From the records, as well as taking into consideration the distribution charts of Tasman and Tromp (1943) and Tromp (1943) for southern Turkey and later statements by Tromp (1952), it would appear that the late Cretaceous-early Tertiary deposits of the Near East can be subdivided microfaunistically into two zones: a *Guembelina-Globotruncana* zone of definite Cretaceous age and a *Globigerina-Globorotalia* zone, regarded by some authors as transitional between Cretaceous and Tertiary, but placed by others in the Tertiary. The junction between these two zones has always been taken as the Cretaceous-Tertiary boundary, the problem of the Danian, however, remaining subject to discussion.

As pointed out already by the present writer (1952a), micropaleontological investigations carried out in Israel during 1950—51 revealed some facts of particular interest:

a. Deposits devoid of Ammonites and previously regarded as belonging to the Danian or "so-called Danian", to the Paleocene or to the Lower Eocene (in part), have been shown to carry the typical microfauna of the *Guembelina-Globotruncana* zone in masses. Analysis proved their Maestrichtian age. These deposits were previously assigned to the Danian, Paleocene or Eocene mainly on the basis of their stratigraphic position above strata carrying "typical Maestrichtian" Ammonites (see below, however). Deposits previously regarded to be of Maestrichtian age (again on the basis of the "typical Maestrichtian" Ammonites) turned out to be actually of Upper Campanian age. In some cases even deposits of Campanian age were previously determined as

Danian. (One can easily understand now why Tromp (1949a) stated that the Cretaceous-Tertiary boundary in the Near East cuts through the "so-called Danian", a term which proved highly misleading).

b. After the *Guembelina-Globotruncana* zone there follows in Israel *not* a *Globigerina-Globorotalia*, but a *Globigerina* zone, devoid of both *Globotruncana* and *Globorotalia**, which in turn is followed by a *Globigerina-Globorotalia* zone. The microfaunas of the *Globigerina* and the *Globigerina-Globorotalia* zones suggest a Danian age for the former and a Paleocene age for the latter (up to the appearance of definite Ypresian fauna). Nevertheless, this writer (1952a, see also 1952b, 1953, 1954, 1955), for reasons to be discussed later, was reluctant to draw a definite boundary between the Danian and the Paleocene and preferred to include both units into a "Danian-Paleocene" or "Dano-Paleocene" unit.

Although Grimsdale (1951) does not discuss the problem of the Cretaceous-Tertiary boundary or those concerning the two above-mentioned zones, as established by Henson, Tromp, Nakkady, et. al., he shows on his distribution chart a stratigraphic unit, named by him "? Danian", devoid of both *Globotruncana* and *Globorotalia*, but characterized by important Danian-Paleocene *Globigerinae* in complete agreement with this writer's observations in Israel. In 1952 (1954), Nakkady and Osman recorded a stratigraphic zone of Danian age, devoid of both *Globotruncana* and *Globorotalia* and present between the *Guembelina-Globotruncana* and the *Globigerina-Globorotalia* zones in Egypt. Ten Dam (1952, 1954) states that in Turkey the Paleocene follows unconformably the Maestrichtian, Paleocene *Globorotaliae* and *Globigerinae* following directly Maestrichtian *Globotruncanae*, *Globigerinae* and *Guembelinae* (Germav formation), the Danian being absent.

It follows from these considerations that the deposits at the Cretaceous-Tertiary boundary in the Near East can actually be subdivided into three zones: a *Guembelina-Globotruncana* zone, a *Globigerina* zone and a *Globigerina-Glorobotalia* (and *Truncorotalia*) zone. In some places the *Globigerina* zone is absent, however.

The Globigerina *zone and its importance*

As pointed out lately by Reichel (1952), the *Globigerina* zone is present between the last *Globotruncanae* and the first *Globorotaliae* (*Truncorotaliae*) in the whole Tethys area (compare also Renz 1936, Glaessner 1945, Cuvillier-Szakall 1948, Cita 1948, Cushman 1951, Grimsdale 1951, Reiss 1952a etc.). The microfauna of this *Globigerina* zone points to its Danian age, as assumed by the above authors as well as by this writer and by Nakkady and Osman (1952, 1954). The underlying deposits with *Globotruncana* can easily be correlated with the Maestrichtian, the overlying ones with *Globorotalia* (*Truncorotalia*)—with the Paleocene.

However, throughout the Tethys area (Americo-Caribbean region, Pyrenees, Alps, Apennines, North Africa, Near East, Caucasus-Caspian Sea region, southern Asia) the *Globigerina* zone shows a strongly varying extent, being sometimes completely absent.

In Israel, the *Globigerina* zone shows the same varying extent, being sometimes

* "*Globorotalia*" is referred to in the present paper sometimes *sensu lato*, i. e. including *Truncorotalia*.

greatly reduced or completely absent. The same fact has been stressed also by Nakkady and Osman (1952, 1954) for Egypt.

Ecological factors could hardly have accounted for the varying extent of the *Globigerina* zone or for its complete absence: such ecological factors must have been of minor importance, as witnessed e.g. in the Near East or in the Gulf Coast region of America both by litho- and bio-facies generally so similar for both the Danian and the Paleocene, and such factors can hardly be admitted to have been able to affect (to such an extent!) pelagic-planktonic forms as *Globigerina* and *Globorotalia* or *Truncorotalia*. Even if one shares the doubts about the pelagic habitus of the fossil *Truncorotaliae* or *Globorotaliae* (expressed by a few authors only), one would have to admit that ecological factors could have influenced only the composition of the *benthonic* faunas, the local stratigraphic ranges of certain species or even genera, but not their sequence as the case actually is in all details of the foraminiferal assemblages concerned. And this — e. g. in Israel — over areas sometimes less than one km apart! Furthermore, observations in Israel have shown in a great number of profiles examined that the *Globigerina* zone varies in extent, is present or absent, in accordance with the structural highs and lows.

These considerations lead us to the conclusion that the absence of the *Globigerina* zone reflects the absence of deposits of the *Globigerina* zone age, i. e. of the Danian, either because of non-deposition or because of erosion. Before discussing other aspects of this question, however, we must examine briefly another, often discussed, fact: the faunistic break at the Maestrichtian-Danian boundary.

The Maestrichtian-Danian faunal break

It is a well-known fact that a great number of species and genera belonging to various groups of the animal kingdom disappear suddenly and completely at the end of the Maestrichtian all over the world. The same is true of Foraminifera: all species of *Globotruncana*, *Rugoglobigerina*, *Pseudotextularia*, *Pseudoguembelina*, *Gublerina*, etc., disappear suddenly at the end of the Maestrichtian. The Danian faunas, although containing various benthonic forms occurring already in the Maestrichtian, carry many new species and genera of benthonic Foraminifera together with an assemblage of pelagic-planktonic forms strongly different from the Maestrichtian one.

Various authors have explained this sharp faunal break in an ecologic-biologic way (i.e. universal and drastic changes in environment and/or climate due to the expansion of land-masses and to tectonic activity involving tremendous areas, inability of various organisms to adapt themselves to the new conditions, etc.). Others have offered geological explanations (i.e. gap in the sequence due to tectonic movements, either orogenic or epeirogenic). Actually, each of the explanations admits tectonic activity as the ultimate cause of the sharp faunal break at the Maestrichtian-Danian boundary.

It seems difficult to accept at present a biologic-ecologic explanation for the sharp faunistic change at the Maestrichtian-Danian boundary: In the first place, it is difficult to admit that such an extensive and extremely sudden change of environment and/or climate took place relatively simultaneously all over the world, even if we take into consideration the fact that widespread uplift and intense mountain-building occurred more or less contemporaneously (in the geologic sense) over tremendous areas at the

close of the Cretaceous. Rapidly as such changes in environment might have taken place, they would have had to do so slowly enough to enable us to distinguish — at least in some places — a *gradual* extinction of the various species and genera, which disappear so very suddenly at the end of the Maestrichtian. Secondly, we would have to admit that some kind of "explosive evolution" took place at the Maestrichtian-Danian boundary, because not only do very great numbers of species and genera disappear there, but above it there appear suddenly many species and even genera, whose gradual development from other forms has nowhere been ascertained. They appear in great numbers at the beginning of the Danian as suddenly as others have disappeared at the end of the Maestrichtian. And this can be observed within centimetres of sediments over large areas. A true, gradual transition from Maestrichtian to Danian faunas has not been observed as yet (as the case is, for example, with the very gradual transition from Danian to Paleocene faunas). Obviously, many species and genera survive the Maestrichtian-Danian "break" and continue their development in later times, a fact which has no bearing whatever on the importance of this break and which has its parallels in many other major faunal breaks between systems or eras throughout the geologic column.

It seems, therefore, that the sharp faunal change at the Maestrichtian-Danian boundary must be explained by the lack of part of the sedimentary record, by a gap in the sedimentary record due to non-deposition or erosion, caused by tectonic movements, either oro- or epeirogenic, at least in those areas examined up to the present. Should deep-sea deposits become known to us, it is probable that they will yield true "transitional" Maestrichtian-Danian faunas; such deposits are, however, unknown as yet.

The sharp faunal break between Maestrichtian and Danian is geographically extremely widespread and is doubtless evidence of the fact that major events have taken place at the boundary between these units. The change from Danian to Paleocene faunas is hardly comparable in importance with that from Maestrichtian to Danian ones.

Continuous or discontinuous sedimentation?

As we have seen, both the faunal break between Maestrichtian and Danian and the observations on the *Globigerina* zone point to an unconformity between Maestrichtian and Danian (or between Maestrichtian and Paleocene, if the Danian is lacking). As far as microfaunas are concerned, this fact has been lately emphasized by Wicher (1953). As far as megafaunas are concerned, the Maestrichtian-Danian unconformity has been discussed lately in detail by Jeletzky (1951). This latter author emphasized that, as far as observed up to the present (and including the type-section of the Danian— not as stated by Tromp [1949a]), there is an extremely sharp mega and microfaunistic break noticeable between the Maestrichtian and the Danian, accompanied by a more or less discernible physical break in the strata. Jeletzky (op. cit.) points out that, even in those places where continuity of sedimentation was assumed to have prevailed from the Cretaceous into the Tertiary, this assumption turned out later to be incorrect. Jeletzky, in discussing Tromp's (1949a) conclusions, therefore, states that the continuity of sedimentation from the Upper Cretaceous into the Lower Tertiary in the Near East ("if such continuity really exists") must be regarded as a rare exception. We shall, however, not overlook the fact that Jeletzky regards the Danian as belonging

to the Lower Tertiary, a fact which has considerable bearing upon the whole discussion of the Cretaceous-Tertiary boundary. For, as long as one regards the Danian as belonging to the Upper Cretaceous, the most significant break occurs within the late Cretaceous (between Maestrichtian and Danian), both as far as fauna and physical evidence are concerned, and, therefore, no major boundary can be recognized between Cretaceous and Tertiary (i. e. between Danian and Paleocene). But, if we disregard the fact that the Danian has originally been defined as a stage of the Upper Cretaceous and consider the whole problem logically on the basis of strong evidence, we must share the opinion expressed by many paleontologists and stratigraphers (Grossouvre, Nielsen, Rosenkrantz, Harder, Kayser, Morozowa, Besrukow, Jeletzky, etc.) that the Cretaceous-Tertiary boundary should be placed at the limit between the Maestrichtian and the Danian and *not* at that between the Danian and the Paleocene. In this case it follows immediately that the Cretaceous-Tertiary boundary is characterized in almost all areas examined up to the present by an unconformity of varying extent. Exceptions to it are a few places where sedimentation from the Maestrichtian into the Danian is still regarded to have been continuous, as for example, Apennines and certain places in North Africa (including Egypt). Since there is a sharp faunal change also in those regions and the conclusions on the continuity of sedimentation were based mainly on field evidence (lately found inexact in several cases), it seems that those conclusions will still need revision. Indeed, in many places where continuity of sedimentation has been recorded on the basis of field evidence, significant unconformities were later proved on the basis of fauna and even on the basis of more exact "physical" examination. As pointed out by LeRoy (1951), distinct physical evidence must not necessarily be discernible and the most reliable means of detecting unconformities are the *fossils* occurring on both sides of them. Especially in the case of disconformities there might be no other than paleontological proof of their presence, and for this reason many extensive unconformities remain unrecognized. Distinct field evidence might be lacking especially in those cases where the sediments on both sides of the unconformity are soft (e.g. the Navarro and Midway sediments of the American Gulf Coast region, the Germav formation of Turkey, etc.). That field evidence has only a "relative value" has been lately emphasized by Cuvillier (1953) and Ten Dam (1952, 1954), who stressed the importance of laboratory methods to prove the distinctness of sediments which in the field and megascopically appeared to be identical. In Israel, chemical analysis of rocks from both sides of the Maestrichtian-Danian boundary — from strata only some tens of centimetres apart stratigraphically and from fairly "complete" sections in synclinal areas (see above) — reveals changes sudden and significant enough to indicate a gap at the Maestrichtian-Danian boundary in support of the (micro)-paleontological evidence. In Egypt the Mesozoic-Cenozoic boundary (which is placed by Tromp at the top-limit of the Maestrichtian) can be detected by drilling-speed analysis (Tromp 1951). Microfacies analysis revealed the great distinctness of strata in Egypt (Kurkur), strata which have been regarded to have been deposited continuously and to be intimately related as far as their facies development is concerned (Cuvillier 1953). In Turkey an unconformity between the Maestrichtian and the Paleocene (!) can be detected also by calcimetry and electric log within an apparently monotonous shale-series (Germav formation) previously believed to have been deposited without interruption (Ten Dam 1952, 1954).

Although he recognized the sharp faunal break at the Cretaceous-Tertiary boundary ("Senonian-Eocene boundary", as called by Tromp), Tromp (1949a, 1951, 1952) emphasizes that the sedimentation from the Cretaceous into the Tertiary was continuous in the Near East. Henson, on the other hand, speaks (1938) about unconformities, stratigraphic condensations and imperceptible gaps; and in 1951 about faunal breaks and diastems which are not necessarily accompanied by any change in facies, some of these breaks being "local and others extensive, the latter expanding into erosional gaps in the sequence". Baker's and Henson's (1952) schematized columnar section, illustrating stratigraphic variations in the Zagros-Persian Gulf oil-field belt, shows erosional unconformities associated with gaps due to non-deposition at the Cretaceous-Tertiary boundary both in the foreland and in the geosynclinal belt. An important nonsequence between Upper Cretaceous and Paleocene is recorded by Kent, Slinger and Thomas (1951) from the Zagros ranges. LeRoy (1953) records both faunistic and lithologic evidence for an unconformity (disconformity) between Upper Cretaceous (Maestrichtian) and Tertiary from Maqfi (69 km NE of Qasr Farafra, Egypt). The distribution charts of Tasman and Tromp, and of Tromp (1943) show the absence of the *Globigerina* zone in the Urfa and Gaziantep regions of Turkey and, therefore, as we have seen, the absence of the Danian. TenDam's (1952, 1954) statements concerning the Germav-shales of Turkey leave no doubt about the absence of the Danian in (at least southern) Turkey and about the presence of an unconformity between Maestrichtian and Paleocene. Nakkady's and Osman's (1952, 1954) statements (especially if compared with Nakkady's [1949, 1950] and LeRoy's [1953] publications) leave little doubt about an unconformity between Cretaceous (Maestrichtian) and Tertiary in Egypt. It is noteworthy that LeRoy's (1953) correlation table of the Maqfi section shows an unconformity between Cretaceous and Tertiary at El Guss Abu Said (Farafra), as well as at Kharga Oasis. Cuvillier (1948) abandons his earlier (1930, 1934) view that conformity exists at Farafra Oasis, considered by many authors to be a classical example of a region where sedimentation was continuous. In 1953, Cuvillier states clearly that pre- and post-Danian unconformities are present in Egypt.

Microfaunistically, the major faunistic break at the Cretaceous-Tertiary boundary in the Near East is revealed not only by the sharp range-limit of many species and — still more important — many genera, but also by any kind of quantitative analysis (per species, genera, families, bionomic groups, etc.), a fact pointed out earlier by Tromp (1949a, 1949b) and lately by Ten Dam (1952, 1954) and ascertained by this writer in Israel. Some of Tromp's statements must be corrected, however (compare also Ten Dam 1952, 1954). The accompanying table shows the stratigraphic and (highly schematized) the quantitative distribution of genera and subgenera, usually regarded as pelagic, from Senonian to Eocene deposits of Israel (see explanations to the table).

Analysis of the observations made on late Cretaceous-early Tertiary deposits in the Near East and their comparison with those made on deposits of the same age in other parts of the world reveals complete agreement: the Maestrichtian-Danian boundary is characterized by a sharp faunal break, accompanied by a physical break, which can be detected by various methods and which indicate discontinuous deposition and the presence of an unconformity at the end of the Maestrichtian. The varying extent or absence of the *Globigerina* zone (which follows the *Globotruncana* bearing

Maestrichtian) reflects the carrying time-span of the Maestrichtian-Danian unconformity, involving sometimes the whole Danian, in which case *Globorotalia*- and *Truncorotalia*-bearing strata follow directly upon *Globotruncana*-bearing Maestrichtian strata.

It is noteworthy that Henson's (1938) distribution chart shows *Globorotalia* to occur rarely together with *Globotruncana*. His reference to "*Globorotalia stuarti*", however, points to the fact that he included some single-keeled *Globotruncanae* in the genus *Globorotalia*. The record of rare *Pseudotextularia* and large ornamented *Guembelina* (i. e. *Pseudoguembelina*) together with *Globorotalia* of the *simulatilis-velascoensis* group, as shown on Henson's (1938) distribution chart, involves doubtless reworked specimens (Henson himself states the mixing of faunas due to redeposition). The record of *Bolivina incrassata* Reuss together with the above-mentioned *Globorotaliae* involves either reworked specimens or another species (?*B. midwayensis* Cushman). As far as Nakkady's (1949, 1950) publications are concerned, his distribution charts show clearly the varying extent of the *Globigerina* zone (evidently included by him in the *Globigerina-Globorotalia* zone). Some of his statements (especially 1949), however, doubtless need revision, as they agree neither with the observations by Grimsdale, LeRoy, Ten Dam and the present writer in the Near East, nor with those of other authors in various regions of the Tethys area. Among them is the occurrence of rare *Globorotalia simulatilis* and *G. velascoensis*, as well as of *G. colligera* and *G. deceptoria* in Maestrichtian deposits. The former two species are known from many countries, but never in association with pre-Paleocene faunas (compare also Grimsdale 1951, Reiss 1952a, Reichel 1953, etc.) (*Truncorotalia* is generally unknown in pre-Paleocene deposits). The last two named *Globorotaliae* are questionable as to their generic position. Furthermore, Nakkady's (1949) statements concerning these *Globorotaliae* are directly contradicted by Nakkady and Osman (1952, 1954) in their record of a zone devoid of both *Globotruncana* and *Globorotalia*. Another point is that Nakkady does not mention reworked Foraminifera, as mentioned already by Henson (1938) and as observed by this writer in Israel. The extremely rare specimens of *Globotruncana* occurring in *one* case with Danian Foraminifera (Nakkady 1949) are doubtlessly reworked and the same is true of the occurrences of *Pseudoguembelina* as single specimens in post-Maestrichtian strata. It is also interesting that Nakkady does not mention any of the various important and abundantly occurring Danian-Paleocene *Globigerinae* of the Tethys area (*G. pseudobulloides* Plummer, *G. triloculinoides* Plummer, *G. compressa* Plummer) (see Brotzen, Cushman, Grimsdale, Plummer, Reichel, Reiss, etc.). The ranges of *G. linaperta*, *G. bulloides* and *G. cretacea* as given by Nakkady are also highly doubtful and the absence in his faunal lists of *Rugoglobigerina* of the *rugosa*-group is conspicuous.

A more detailed discussion of Faris' (1947) paper is not possible until more is known of the exact distribution of the fauna mentioned by him in his section. The *Pecten* horizon and the Lower Esna-shales (included by Faris in his columnar section in the Danian, designated in the text as Maestrichtian) are evidently not younger than lowest Maestrichtian (possibly uppermost Campanian, especially if we consider the occurrence of *Baculites anceps* together with *Scaphites kambysis*, *Schizorhabdus libycus*, etc.). As far as the age of the overlying shales, chalky marls and Upper Esna-shales is concerned, only renewed and careful analysis will provide a definite answer. The latest researches on the Esna-shales (Nakkady, 1949, 1950, 1952, LeRoy 1953) have shown them to be mostly (as a lithogenetic unit) of Danian-Paleocene age (these considerations apply obviously to the Upper Esna-shales only, not to the Campanian-Maestrichtian "Lower Esna-shales", a matter overlooked by many authors). Faris' record of *Globorotalia* cf. *velascoensis* (the only species of Foraminifera from his faunal list to which importance can be attributed) would point to a Paleocene age of his "Upper Esna-shales". On the other hand, together with this *Globorotalia* there occurs a megafauna which includes many species occurring in the Campanian-Maestrichtian of Egypt. The lack of a distribution-chart of the species recorded by Faris makes it also impossible to gather where exactly in the shales the mentioned *Globorotalia* occurs. Further research will have to clear up this matter together with various other points concerning the megafaunas of deposits of Egypt, assumed to be of Danian age.

Since, as we have seen, the Cretaceous-Tertiary boundary should be placed at the top-limit of the Maestrichtian, this boundary in the Near East should be placed at the top-limit of the *Guembelina-Globotruncana* zone [i.e. top of Maestrichtian (not of Senonian!)], as has been done in fact by Henson, Tromp, Nakkady, LeRoy, Ten Dam, only that differences in stratigraphical nomenclature made them appear to disagree.

All observations made hitherto in the Near East point to the fact that the Cretaceous-Tertiary contact is an unconformable one.

The nature and causes of the Cretaceous-Tertiary unconformity in the Near East

Considering the conclusions arrived at in other parts of the world, where the Maestrichtian is separated from various parts of the Danian (or from the Paleocene) by an unconformity which corresponds to the Laramic phase of Stille, as well as considering the observations made in the Near East countries, both in the foreland and in the geosynclinal belt, it follows that the unconformity at the Cretaceous-Tertiary boundary in this region corresponds to the (either oro- or epeirogenic) effects of this phase, which has affected tremendous areas.

Opinions on the nature of the tectonic movements in late Cretaceous-early Tertiary times (and in post-Paleozoic — pre-Neogene times in general) in the Near East are still divided and far from being conclusive (compare Picard 1943, Henson 1950, 1951, Tromp 1951, Baker and Henson 1952, Baker 1953, Ball 1953).

Since the Cretaceous-Tertiary unconformity is witnessed in Israel (and in the Near East in general) mainly by disconformities, diastems, etc., and angular unconformities are rather rare (geosynclinal belt, northern Egypt, etc.), it seems that epeirogenic (?synorogenic) uplift, rather than true orogenic, compressional movements was responsible for this unconformity. On the other hand, it seems that most, if not all, present-day major structures in this area began to be formed at least in pre-Senonian times (Turonian, perhaps earlier) (see also Avnimelech 1936, 1949a, 1949b, 1950a, 1950b, 1951, Avnimelech and Reiss 1953, Bentor and Vroman 1951, 1952, Baker and Henson 1952, Ball 1953, Henson 1951, Shaw 1947, Tromp 1951, etc.). This is witnessed by the great reduction or complete absence of the Danian (*Globigerina* zone) in anticlinal areas in Israel, by the considerable variations of thickness of litho- and bio-facies, and by the distribution of facies-types and their structural relationship to present-day geologic structures of deposits of Senonian-Eocene age in Israel and other Near East countries. The observed gaps in the sequence in Israel, which sometimes involve the whole Senonian—Paleocene and Lower Eocene lying directly upon Turonian, provide further evidence. The presence of areas of relative elevation accounted apparently for the varying extent of the *Globigerina* zone (i. e. of the Danian) or for its complete absence over areas only very short distances apart. Some of these highs were covered by the sea in later Danian times, others were submerged only in the Paleocene (compare also Cuvillier 1953).

The Danian-Paleocene boundary

Although, for faunistic reasons, the correlation of the *Globigerina*-zone of the Tethys area with the type-Danian and that of the *Globigerina-Globorotalia* (*Truncorotalia*)-zone with the Paleocene seemed entirely justified, this writer (1952a, 1952b, 1953, 1954, 1955) was reluctant to draw a definite boundary between the Danian and the Paleocene in Israel and preferred to include both units in a "Dano-Paleocene" unit. Indeed, as pointed out by Reichel (1953), the genus *Globorotalia* (and *Truncorotalia*) is absent in boreal Europe and, therefore, the boundary between the *Globigerina* zone and the *Globigerina-Globorotalia* (*Truncorotalia*) zone cannot be traced in the type-area of the Danian. On the other hand, there are many strong faunistic reasons for correlating the

Globigerina zone of the Tethys area with the Danian of Denmark and Sweden [see Brotzen's (1948) correlated table for the upper Danian and for the Paleocene in both hemispheres as well as Grimsdale's (1951) and Cushman's (1951) distribution charts, and compare this writer's (1952a) publication].

The answer whether *Truncorotalia* and *Globorotalia* appear only with the beginning of the Montian or already in the latest Danian must await further study. Meanwhile we must adhere to the usage of drawing the Danian-Paleocene boundary in the Tethys area between the *Globigerina* and the *Globigerina-Globorotalia* (*Truncorotalia*) zones (see also Reichel 1953), without accepting, however, Reichel's opinion that this boundary corresponds to the Cretaceous-Tertiary boundary.

Considering White's (1928—1929) distribution charts* as well as Bolli's (1952) publication (especially table 1), the lower Velasco shale of Mexico and the lower zone of the Lizard Springs formation of Trinidad belong to the *Globigerina-Globorotalia* (*Truncorotalia*) zone and must, therefore, be correlated with the Paleocene [contrary to this writer's earlier (1952a) opinion]. The lower Midway of the Gulf Coast region belongs to the *Globigerina* zone and represents Danian deposits, the upper Midway belongs to the *Globigerina-Globorotalia* (*Truncorotalia*) zone and must be correlated with the Paleocene, as has been done by Brotzen (1948) on the basis of other microfaunistic considerations (compare also Grimsdale's [1951] distribution chart).

Megapaleontology, micropaleontology and the Cretaceous-Tertiary boundary in Israel and the Near East

Observations in Israel reveal a particularly interesting fact requiring careful consideration: the megafaunistic boundary between Cretaceous and Tertiary cannot be traced — or at least not always — on the basis of "principles" valid for example for the boreal Eurasian regions. Since, as already pointed out above, Ammonites, Rudists, Belemnites, etc. disappear in the Near East at various stages of the Upper Cretaceous, the Cretaceous-Tertiary boundary is difficult to determine on the basis of megafossils and has often been misinterpreted. Furthermore, considering the conclusions arrived at by this writer (on the basis of microfaunas) with regard to Senonian-Eocene deposits in Israel, it seems that the age-determination of various deposits, carried out on the basis of megafauna in other Near East countries, needs revision. Regarding Israel, recent megapaleontological research has supported this writer's stratigraphical conclusions.

The occurrence and especially the sequence in Israel of a great number of species of small Foraminifera, characteristic of various stages and substages of the Upper Cretaceous and Lower Tertiary in their type-areas (a fact ascertained by this writer on the basis of literature and of rich topotype-material received from various parts of the world), made it possible to correlate directly deposits of Israel with the representative sections or type-sections of the respective units. Comparison of the microfaunas of Israel with those of Europe proved also beyond doubt that the Ammonite genus *Libycoceras*, previously regarded as typically Maestrichtian, does not occur in post-Campanian strata in Israel. Detailed studies on the Cretaceous Ammonites of

* Wicher's (1949) copy of White's tables is incorrect in the case of *Glbrt. membranacea* and *G. velascoensis*.

Israel, carried out in the last years by A. Parness of the Hebrew University, entirely support this conclusion.

Parness (personal communication) distinguishes two main subdivisions of the Upper Campanian in Israel: an upper one where the Campanian phosphate-beds (above the flint) occur (see also Reiss 1952a) with "*Hamites*" *wernickei* (Woll.), *Bostrychoceras* sp., "*Ptychoceras*" sp., *Libycoceras chargense* Blanckenhorn., *L. ismaeli* Zittel, *Baculites vertebralis* Lmck., etc., and a lower one (where phosphates and the highest flint-layers occur) with *Libycoceras ismaeli* Zittel, *Baculites syriacus* Conr., *B. vertebralis* Lmck., *Hoplitoplacenticeras marroti* Coquand, etc. It may also be interesting that Parness identified *Scaphites kambysis* Zitt. from flint-layers (!) of the Irbid region (T.J.) (compare, however, for example, Faris 1947).

The erroneous opinion that *Libycoceras* is characteristic of the Maestrichtian has apparently two main sources: a. the fact that *Libycoceras* is — at least in Palestine — one of the last Ammonites, the deposits following the *Libycoceras*-carrying strata and devoid of Ammonites having been placed already in the Danian (Picard 1931), and b. the erroneous correlation of the *Bostrychoceras polyplocum* zone with the Lower Maestrichtian, an error perpetuated until very recently by many authors (e.g. Haug, Spath, Gignoux, Muller and Schenk, etc.) (for an exhaustive discussion of this problem see Jeletzky 1951). It is noteworthy in this connection that *Libycoceras* has been recorded (e.g. Blanckenhorn 1921) from strata carrying *Bostrychoceras polyplocum* Roem., but never from deposits carrying Maestrichtian fauna.

Local ecological conditions often affect the stratigraphical ranges not only of species, but of genera and, indeed, whole groups of animals to a considerable extent and are, in fact, one of the causes for the differentiation between holobiontic and phainobiontic ranges. For this reason the absence of a certain group of fossils, when taken as a basis for age-determination, might be highly misleading, especially in those cases where faunal sequences cannot be observed. Thus the absence of Ammonites in the Maestrichtian of Palestine was one of the main causes for the misinterpretation of the Campanian, Maestrichtian and Danian, as well as of the Cretaceous-Tertiary boundary in this region.

SUMMARY AND CONCLUSIONS

a. The Cretaceous-Tertiary boundary should be placed in the Near East at the junction between the *Guembelina* (more exactly, *Pseudoguembelina*)-*Globotruncana* zone and the *Globigerina*-zone. This boundary corresponds to that between the Maestrichtian and the Danian.

b. In Israel and other Near East countries deposits of early Tertiary age are separated from deposits of late Cretaceous age by an unconformity of varying time-span. Deposits of Danian age are often completely lacking; this, at least as far as Israel is concerned, in areas of what are at present anticlinal structures. Epeirogenic (? synorogenic) movements, rather than compressionable ones, are considered to have been responsible for this unconformity.

c. Although it seems that the correlation of the *Globigerina* zone with the Danian and that of the *Globigerina-Globorotalia* (*Truncorotalia*) zone with the Paleocene (up to the appearance of Ypresian faunas) is justified, the *exact* determination of the boundary between the Danian and the Paleocene in the Tethys area needs further study.

d. A formal decision concerning the position of the Danian must be reached by the competent authorities (Stratigraphic Commission, International Geological Congress). Although such a decision might be of purely academic interest, it will help avoid many misunderstandings and misinterpretations. The fact that the Danian has

been originally defined as a stage of the Upper Cretaceous might present an obstacle from the formal point of view to including the Danian in the Lower Tertiary, although both fauna and relationship to underlying and overlying formations in various parts of the world (including the type-section of the Danian) justify this procedure in a logical manner. It will perhaps be desirable to create a new series (epoch) to include the Danian and the Paleocene.

e. Such terms as "Cretaceous-Eocene" or "Senonian-Eocene" boundary must be avoided as incorrect and misleading. The Maestrichtian is an independent stage of the Upper Cretaceous, younger than and equal in rank to the Senonian stage as originally defined, and neither the Danian nor the Paleocene belong to the Eocene.

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Explanations to the accompanying table

(The table is based entirely on observations in Israel and the quantitative representation is highly schematized).

1. The present writer is not convinced that the Danian and later *Globigerina* really belong to the same genus as the pre-Danian ones: wall structure, pore size, rules of coiling, etc. will make it perhaps necessary to distinguish different genera or subgenera [compare also Bolli's (1952) remark on the *Globigerinae* from the Lizard Springs formation (op. cit. p. 672)]. For the time being they are included in one group.

2. The genus *Globigerinella* has been subdivided in the table into three groups:

Group 1. Species with more or less spherical chambers (e.g. *G. aspera* Ehrb.).

Group 2. Species with laterally compressed chambers, the test having often a subacute or acute periphery (e.g. *G. messinae* Bronnimann); walls dense, spinose or granular.

Group 3. Includes a single species, *G. micra* (Cole), having laterally compressed chambers, a subacute or acute periphery, but hyaline, very finely-pored, thin walls. It remains questionable whether *G. micra* (Cole) really belongs to the genus *Globigerinella*.

3. The first unquestionable *Globigerinoides* appear in Israel with the beginning of the Middle Eocene. In the higher parts of the Lower Eocene (Lower Eocene III, *Uvigerina* zone), however, there occurs a Globigerinid whose systematic position is uncertain: it lacks the typical aperture characteristic of *Globigerina*, but neither has it the secondary apertures characteristic of *Globigerinoides*. The wall structure reminds one of *Sphaeroidinella*. It might belong to a new genus.

4. It is questionable whether *Globotruncana citae* Bolli, which occurs in deposits of late Campanian and Maestrichtian age of Israel, is really a *Globotruncana*. As suggested by Dr. Bolli (written communication), it might belong to a new subgenus of *Globotruncana*.

5. The writer retains for the time being *Globigerina compressa* Plummer in the genus *Globigerina*. Some authors regard it as belonging to *Globorotalia* s. str. It might be significant in this connection that this species occurs in boreal Europe, where the genus *Globorotalia*, or its allies *Truncorotalia* and *Turborotalia*, are absent.

6. The exact systematic position of some *Globorotaliae* or *Truncorotaliae* is uncertain. Thus the species occurring in Israel and believed by this writer to be that recorded by Grimsdale (1951) as *Globorotalia* aff. *globigeriniformis* van Bellen cannot be assigned with certainty to either *Globorotalia*, *Truncorotalia*, or *Turborotalia*. Although fully aware of the fact that this species is not a typical *Truncorotalia*, the present writer included it in the genus *Truncorotalia*.

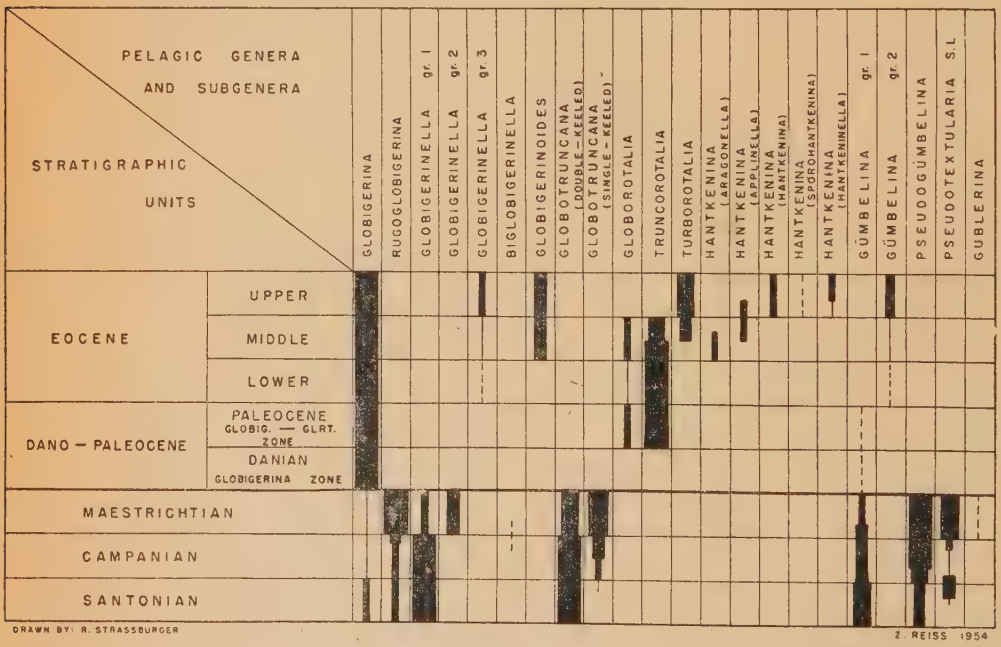
7. The genus *Gumbelina* has been subdivided into two groups:

Group 1. Species with a typical *Guembelina* aperture and test morphology characteristic of this genus (*Guembelina crinita* Glaessner, however, the single species of *Guembelina* occurring in the Danian and Paleocene of Israel, needs further study to determine definitely its systematic position).

Group 2. Thin-walled species with apertures which resemble rather those of *Virgulina* (compare Hofker 1954).

8. After the erection of the genus *Pseudoguembelina* for certain ornamented Guembelinids, the systematic position of some species (e. g. *Guembelina plummerae* Loetterle) has become uncertain. It seems that *Guembelina plummerae* is nearer to *Pseudotextularia* s. l. (see below) than to either *Guembelina* or *Pseudoguembelina* (the writer has compared specimens of this species from Israel with such *Pseudoguembelinae* occurring in Israel as *P. costulata*, *P. punctulata*, *P. excolata*, etc.).

9. Until a revision of the genera (?) *Ventilabrella*, *Planoglobulina* and *Pseudotextularia* is carried out, these are included here under *Pseudotextularia* sensu lato. The relationship between biserial forms of *Pseudotextularia* s. str. and certain Guembelinids (e. g. *Guembelina? plummerae*) needs further study. The systematic position of *Guembelina* (*Guembelina*, *Ventrilabrella*) *deflaensis* Sigal, which occurs in the Santonian of Israel with *Globotruncana concavata* (Brotzen) (= *G. ventricosa* Reiss 1952a [non White] — *G. asymmetrica* Sigal) is uncertain. This species is perhaps nearer to *Gublerina* than to either *Guembelina* or *Ventilabrella*. It might belong to a new genus or subgenus.



REMARKS ON THE AGE OF SOME LATE CRETACEOUS AND EARLY TERTIARY STRATIGRAPHIC UNITS OF ISRAEL

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ABSTRACT

The age of certain "controversial" stratigraphic units of Israel is discussed, viz. the strata with *Pecten obrutus* Conr. (a biostratigraphic unit); the "Mottled zone" (a lithofacies development); the Sar'a beds, the Ghareb chalk and the Taqiya marls (lithogenetic units). Foraminifera constitute the main basis for the various age determinations.

INTRODUCTION

In the present note the age of certain "controversial" stratigraphic units in Israel is discussed. These units have been previously regarded to be partly or entirely of Danian, Paleocene or Lower Eocene (part) age.

The actual age of each unit as given here has been established on the basis of microfaunas (Reiss 1952a, 1952b, 1954, 1955). The accompanying tables show the position of the units discussed as interpreted by various authors, as well as the actual position of the respective units as established by the present writer.

Most of the local lithological units have been inadequately defined, their type sections or type localities having been published in such a manner as to make exact reexamination impossible. Contacts with underlying or overlying units have been recorded in an ambiguous manner and names of formations have been applied incorrectly in various instances. Time significance has been attributed to purely lithologic units or to local facies developments, leading to confusion between time-stratigraphic and rock-stratigraphic units.

Confusion has arisen from the fact that internationally recognized and well-defined stratigraphic names have been used indiscriminately and incorrectly by various authors. Another source of various misinterpretations is the subdivision by Blanckenhorn of the Senonian into Santonian, Campanian and Danian. He did not differentiate the Maestrichtian but included it mostly in the Danian and not in the Campanian, as assumed by some later authors. Some authors included in the Maestrichtian the Danian-Paleocene "transition-beds" as well (e.g. Beadnell 1924). The term Paleocene was generally rarely used in the Near East and the Paleocene was mostly included in the Lower Eocene, sometimes in the Danian.

STRATA WITH *PECTEN OBRUTUS* CONRAD

Bituminous strata carrying *P. obrutus* Conr. were previously regarded as belonging to the Danian (Blanckenhorn 1914, 1915), to the Campanian (Blanckenhorn 1921),

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to the so-called Danian (Picard 1931), to the Maestrichtian (Dubertret 1933), to the Danian (Blake 1936, Avnimelech 1936), to the Danian, with reservation (Picard 1938), to the Upper Cretaceous (Henson 1938) or to the Danian-Paleocene transition (part) (Picard 1943).

According to Blanckenhorn (1915, 1921), *P. obrutus* is identical with *P. farafrensis* Zittel and with *P. mayer-eymari* Newton. *P. obrutus* has been recorded by Blanckenhorn both from the Campanian and from the Danian (in his sense) (see especially Blanckenhorn 1921, as well as Picard's [1938] remarks on the occurrence of this species together with certain Baculites). *P. farafrensis* is recorded from late Campanian-early Maestrichtian deposits of Egypt (compare also Faris 1947, Tromp 1951) and *P. obrutus* is listed by Blanckenhorn in his various publications together with undoubtedly Upper Campanian fauna (*Bostrychoceras polyplocum* Roemer), as well as from Maestrichtian strata (Danian of Blanckenhorn, part). Avnimelech (1936) records *P. obrutus* from strata of Danian age, which, however, have been examined micropaleontologically and found to be of Lower Maestrichtian age. On the other hand, Avnimelech (op. cit. p. 57) records *P. obrutus* also with a megafauna which points clearly to a late Campanian age.

This writer has examined samples from strata carrying *P. obrutus* (s. l.) from various places in Israel; most of these samples carry a microfauna which points to a lowermost Maestrichtian age (*Neoflabellina interpunctata-reticulata* [Wicher], *Bolivinoides draco draco* [Marsson], etc.). A very few samples have been shown by the microfauna to belong to the uppermost Campanian (*Globotruncana calcarata* Cushman, *Bolivinoides draco miliaris* Hiltermann and Koch, etc.). A sample from Nebi Musa (Judean Desert), deposited in the Geological Survey of Israel (Picard collection) and labelled: "Uppermost bitumen horizon, Nebi Musa, with *P. obrutus*", has been examined micropaleontologically and shown to be of early Maestrichtian age.

Bituminous shales with *P. farafrensis* Zitt. (det. A. Parness) from the Dead Sea region were equally found to be of early Maestrichtian age.

From these considerations it results that *P. obrutus* (=*P. farafrensis*=*P. mayer-eymari*) occurs in strata of late Campanian and early Maestrichtian age, but does not occur in post-Maestrichtian strata.

MOTTLED ZONE

Name introduced by Picard (1931). Previously regarded as being of Danian age (Blanckenhorn 1915) (in his sense), as belonging to the so-called "Danian" (Picard 1931), to the Maestrichtian (Dubertret 1933), to the Danian, with reservation (Picard 1938), to the Upper Cretaceous (Henson 1938), to the Danian (Blake 1936, Avnimelech 1936), the "mottled" rocks are actually a lithological development occurring in Israel mainly at different levels of the Maestrichtian and found lately to occur also in Danian and early Paleocene strata. The term "zone" must therefore be abandoned (at least in a stratigraphic sense). Samples from the lower part of the "Mottled zone" of the Judean Desert (see Picard 1931), examined by this writer, were found to be of Maestrichtian age.

SAR'A BEDS

Name introduced by Avnimelech (1936). Originally subdivided (Avnimelech, op. cit.) into two parts: a. Lower Sar'a beds and b. Upper Sar'a beds.

Lower Sar'a beds

Previously regarded as being of Lower Eocene age (Avnimelech 1936), as belonging to the Cretaceous-Tertiary transition (Henson 1938) or to the upper part of the Danian-Paleocene transition (Picard 1943), these strata correspond partly to Picard's (1928) "Uebergangsschichten", mainly to the strata with Porifera included by Shaw (1947) in the Ghareb Chalk, partly to the Lower Eocene of Avnimelech (1939), as well as to the Paleocene (part) of Shiftan (1952).

The lower Sar'a beds can actually be subdivided into two units: a lower, chalky unit, carrying Porifera and some rare *Pecten* sp. ind. and forming the greatest part of the lower Sar'a beds, of Maestrichtian age; and an upper one, composed of soft, greenish-grey, calcareous shales (not differentiated by earlier authors), of Danian and Paleocene age. These latter shales are actually typical Taqiya marls (see below). The lower Sar'a beds have a wide distribution in Israel. Obviously they are partly time-equivalents of the strata with *P. obrutus*.

Upper Sar'a beds

Previously regarded as belonging to the Lower-?Middle Eocene (Avnimelech 1936), Lower and Middle Eocene (part) (Henson 1938), Lower Eocene (Avnimelech 1939), these strata are for the greatest part of the Lower Eocene age. The basal beds, however, (also differentiated lithologically) are still of late Paleocene age.

Thalmann's (1942) record of *Hantkenina* from the Sar'a beds is based on a misinterpretation of Henson's (1938) table: the upper Sar'a beds belong to the lower division of Henson's "Lower and Middle Eocene" and do not carry *Hantkenina*.

The upper Sar'a beds are widely distributed in Israel.

The earlier assumption that the lower Sar'a beds can be distinguished from the upper ones by the size of the occurring Porifera (reported to be small in the lower and large in the upper Sar'a beds) is unjustified: this writer has examined material from strata carrying large Porifera from western Galilee and found them to be of Maestrichtian age.

GHAREB (OR RHAREB) CHALK

Name introduced by the Petroleum Development (Palestine) Co. (P. D. P.) (Shaw 1947). Previously regarded as being of Maestrichtian-Danian age (Shaw 1947), of late Maestrichtian and Danian age (Bentor and Vroman 1951), of Maestrichtian age (Bentor 1952), this unit is a purely lithologic one.

This unit has not been clearly defined and the section from Naqb el Gharib published by Shaw (1947) and representing apparently the type section is only 10 m thick (the Ghareb chalk attaining sometimes thicknesses up to 80 or more m), neither the lower, nor the upper limit being clearly defined. The contact with the underlying Mishash-formation has been reported to be gradational.

The Ghareb chalk is mainly of Maestrichtian age. However, as ascertained on the basis of carefully sampled sections, it includes, at least in some places in the Negev, strata of uppermost Campanian age ("brown Ghareb" with *Globotruncana calcarata* Cushman, *Bolivinoides draco miliaris* Hiltermann and Koch, etc.). On the other hand, strata determined in the field roughly as "Ghareb" have been shown to be of Danian age. These strata of Danian age are, however, much more clayey and shaly than the

typical Ghareb chalk of Maestrichtian age. They are also much more vividly coloured. The Ghareb chalk includes also typical Sar'a beds (strata with Porifera of Shaw 1947) and occurs associated with "mottled "rocks. As far as the lower limit of the Ghareb chalk is concerned, it is quite clear that the boundary is a fluctuating one: the underlying Mishash formation (P.D.P. nomenclature, see Shaw 1947) includes the flint beds of Campanian age (see also Reiss 1952a) (formerly the "Maestrichtian flint") which follow the Maliha chalk (P.D.P. nomenclature, see Shaw op. cit.), as well as the phosphate beds of Campanian age (see also Reiss 1952a). The latter, however, are related to depositional conditions and structure and their upper limit represents, therefore, no isochronous surface, but a facies limit. For the same reasons, phosphate beds may or may not be present, their place being taken by other rock types. The lower limit of the Ghareb chalk cuts, therefore, across time boundaries to a relatively considerable extent.

TAQIYA MARLS

Name introduced by the Petroleum Development (Palestine) Co. (P.D.P.) (Shaw 1947). Previously regarded as of Paleocene-?Lower Eocene age (Shaw 1947) or as of Danian age (Bentor and Vroman 1951), the Taqiya formation is a lithogenetic unit of Danian and Paleocene age, widely distributed in Israel. It is largely identical with the Esna shales of Egypt (see also Shaw 1947). The Taqiya formation grades laterally into clayey-chalky strata ("Ghareb" of Danian age, see above) or into somewhat siliceous, chalky limestones; the upper part of the Taqiya marls (Taqiya *shales* would be more correct) passes laterally into chalky limestones, chalks or siliceous chalks and limestones, sometimes erroneously assigned to the Lower Eocene. (Compare in this connection the similarity of the Taqiya shales to the lithological characters and development of the Esna shales, as it follows from the publications of Nakkady [1950] and LeRoy [1953], as well as to the Germav formation of Turkey, as described by Ten Dam [1954]). It is noteworthy that a sample from the Paleocene Ranikot formation of Western Pakistan, examined by this writer, is identical in both fauna and lithology with the upper Taqiya formation.

The boundary between the Ghareb chalk and the Taqiya shales is usually clearly discernible in the field. Such lateral facies developments as those mentioned above are, however, sometimes misleading. It must be noted in this connection that the Danian-Paleocene deposits of Israel are separated from the Maestrichtian ones by an unconformity of varying extent, comprising in some places of the country the whole Danian (see Reiss 1954a and 1954b).

REMARKS

Considering the material published by M. and D. Ball (1953), the following should be noted: The various sections (except col. sec. 3, 7, ?4, ?5) need correction in the sense that — roughly — instead of Maestrichtian, there must stand Upper Campanian, instead of Danian and Paleocene, Maestrichtian. In some sections part of the strata shown as Lower Eocene corresponds actually to Paleocene deposits. Some of the strata shown in certain sections as Danian are of late Campanian age (e.g. col. sec. 6: chalky marl with *Ostrea* band). In some cases the higher strata of units shown as Danian and/or Paleocene are actually of Danian-Paleocene age.

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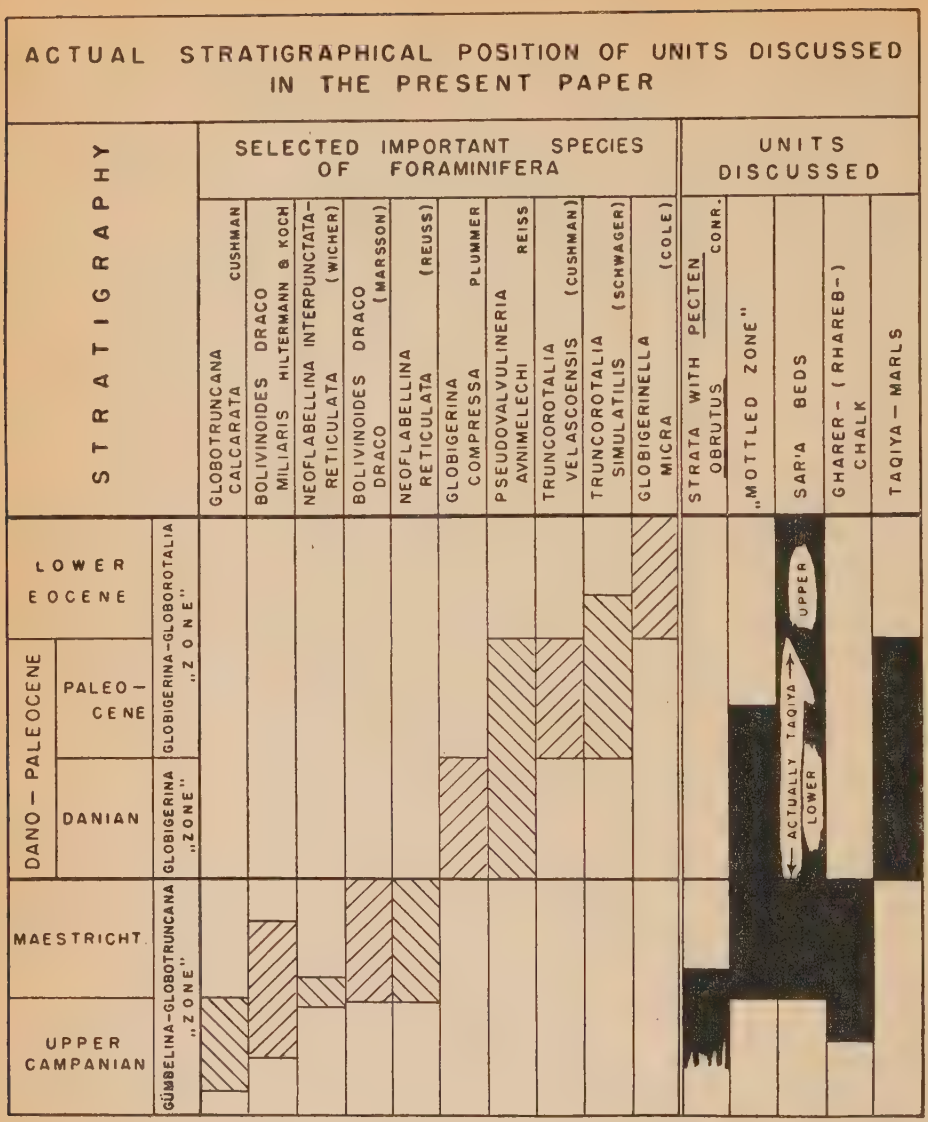
ACTUAL STRATIGRAPHICAL POSITION OF UNITS DISCUSSED IN THE PRESENT PAPER
STRATIGRAPHY
SELECTED IMPORTANT SPECIES OF FORAMINIFERA
UNITS DISCUSSED
LOWER EOCENE
PALEO-CENE
DANIAN
DANO-PALEOCENE
MAESTRICHT.
UPPER CAMPANIAN
GLOBIGERINA-GLOBOROTALIA „ZONE"
GLOBIGERINA „ZONE"
GÜMBELINA-GLOBOTRUNCANA „ZONE"
GLOBOTRUNCANA CALCARATA CUSHMAN
BOLIVINOIDES DRACO MILIARIS HILTERMANN & KOCH
NEOFLABELLINA INTERPUNCTATA-RETICULATA (WICHER)
BOLIVINOIDES DRACO (MARSSON)
NEOFLABELLINA RETICULATA (REUSS)
GLOBIGERINA COMPRESSA PLUMMER
PSEUDOVALVULINERIA AVNIMELECHI REISS
TRUNCOROTALIA VELASCOENSIS (CUSHMAN)
TRUNCOROTALIA SIMULATILIS (SCHWAGER)
GLOBIGERINELLA MICRA (COLE)
STRATA WITH PECTEN OBRUTUS CONR.
„MOTTLED ZONE"
SAR'A BEDS
GHARER-(RHAREB-) CHALK
TAQIYA-MARLS
ACTUALLY TAQIYA
UPPER
LOWER

Z. REISS

LETTERS TO THE EDITOR

Fishes caught on the Mediterranean coast of Israel

Between 200 and 300 species of fishes have been reported hitherto from the Mediterranean coast of Israel. The most comprehensive list published is that of A. Ben-Tuvia[1], who included only species seen by himself, among them some which had previously been recorded from the same area by other authors.

The following list of seven species, not yet recorded from the coast of Israel, shows that there is nothing exceptional in their presence here, most of them having been reported from several other places in the Eastern Mediterranean.

Numerals after the name indicate the inventory number of the fishes in the collection of the Department of Zoology, The Hebrew University of Jerusalem.

Syngnathidae:
Siphonostoma typhle (L.) 28.
Marmara[2], Rhodes[3], Cyprus[4].

Maenidae:
Smaris vulgaris (C.V.) 72.
Marmara[2], Rhodes[3], Syria[5].

Pomacentridae:
Heliases chromis C.V. 129.
Marmara[2], Rhodes[3].

Soleidae:
Dicologlossa cuneata (Moreau) 222.
Marmara[2].
Solea variegata Gthr. 226.
Marmara[2], Rhodes[3].

Triglidae:
Trigla pini Bloch. 244.
Lepidotrigla aspera Gthr. 238.

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The spoilage of local bottled grape juice by Monascus purpureus Went, a fungus newly recorded for Israel

The cause of a serious spoilage of bottled grape juice of the 1954 vintage was investigated on behalf of the Rishon-le-Zion Wine Cellars. During storage a gelatinous sediment had slowly formed and a slow fermentation had set in, and this became apparent on opening these bottles, when the sudden release of the compressed carbon dioxide gas produced during fermentation caused a heavy foaming, also the juice smelt decidedly alcoholic.

Microscopic examination of the spoilt juice showed it to be free from viable yeast cells, but revealed fragments of fungal growth. The wild yeasts associated with the grapes and introduced into the juice had, undoubtedly, been destroyed during the pasteurization process of the juice.

Pure cultures of a characteristic mould fungus were isolated from all bottles examined, and a thick mycelial mat of the same fungus formed on the free surface of the tested bottled juice.

Proof that this fungus was the causal organism responsible for the alcoholic spoilage of the grape juice was demonstrated by subplanting a pure culture of the fungus into flasks of grape juice, which had been sterilized under pressure. The fungus developed and caused a slow alcohol fermentation with CO_2 evolution.

The fungus was fully diagnosed, and from morphological, cultural and physiological studies it agreed with *Monascus purpureus* Went in all essential characteristics.

Its optimum temperature of growth is from 30° to 37°C.

Grape juice is generally adjusted to a *p*H value of about 3.5 in order to prevent bacterial spoilage either in the bottled juice, or during alcohol fermentation by yeasts. An experiment carried out to test the influence of *p*H on alcohol production from grape juice by *Monascus purpureus* showed that the fungus is capable of growing over a wide range of *p*H, and produced even significant amounts of alcohol from juice adjusted to as low a *p*H as 1.7 and also at the high *p*H of 9.9 (the highest *p*H value we actually tested). Optimum *p*H for alcohol production by the fungus appeared to be about 4 to 5, although good yields were also obtained at *p*H 8.5.

Physiological studies revealed that the organism utilizes many carbohydrates as sources of carbon for growth, but not all of these substances are fermented to alcohol, due to the inability of the fungus to produce the appropriate enzyme to break down the specific carbohydrate to reducible and fermentable sugars. Pentoses are not fermented. Amylases are produced and starch is fermented, but invertase is not produced and the fungus is unable to ferment sucrose.

The characteristic purple red pigmentation produced by the fungus, as when grown on maize mashes and on milk, accounting for its specific nomenclature, is not produced on all carbohydrate media. Pigmentation may be very slight or lacking, as on glucose media, or may be salmon or carrot coloured, as was often observed on grape juice and sweet potato media respectively.

The ability, if any, of a number of common moulds to produce alcohol from grape juice was tested. Tested fungi were:

Penicillium glabrum, Mucor javanicum, Botrytis cinerea, Aspergillus oryzae, Aspergillus niger, Fusarium sp. Significant yields of alcohol were produced by *Mucor javanicum*, considerably less, however, than by *Monascus purpureus*. Slight amounts of alcohol were formed by *Fusarium* sp., and even less by *Aspergillus oryzae*. The rest of the tested fungi produced either negligible amounts of alcohol or none at all.

The fungus does not appear to possess antibiotic activity. It was tested on the following organisms: *Escherichiae coli, Aerobacter aerogenes, Sarcina lutea, Pseudomonas fluorescens, Bacillus subtilis, Bacillus cereus, Bacillus polymyxa, Saccharomyces cerevisiae, Sac. ellipsoideis, Torulopsis dubia, Actinomyces griseus, Penicillium glabrum, Fusarium* sp., *Botrytis cinerea, Mucor javanicum, Aspergillus oryzae, Aspergillus niger*.

To prevent spoilage of grape juice by *Monascus purpureus* careful pasteurization must be carried out to ensure the destruction of the thick-walled ascospores of the fungus. Small amounts of sulphur dioxide could be added, although this is not absolutely necessary if pasteurization is properly done. The fungus was capable of growing in non-pasteurized juice containing 120 p.p.m.SO_2, which is almost the maximum amount of SO_2 allowed by law for grape juice. Growth from a heavy inoculum did not occur if juice containing more than 110 p.p.m. SO_2 was pasteurized at 75°C for 30 mins. However, juice without the addition of SO_2 and inoculated with an active culture of the fungus, heated to 100°C for four minutes or more, did not ferment, nor did juice pasteurized at 75°C for 30 mins. and quickly brought up to 100°C for several minutes (3 to 5 mins.). The latter method of pasteurization — maintaining the temperature at 75°C for 30 mins. followed by flash pasteurization at 100°C for several mins. —is the normal practice in industry. Apparently the spoilt bottled juice had not been carefully pasteurized.

As far as the writer is aware, this fungus has not been previously recorded in this country. It was first described in 1895 by Went[1], who discovered the organism in Java, where it was used for colouring rice red, a preparation known as Ang-quac. In 1909, the fungus was found on discoloured rice grains in a fermentation plant in Berlin and its life history fully described by Schikorra[2]. Buchanan[3] was first to report its occurrence in America, on silage. *M. purpureus* is used for brewing Hung-chii, a red wine[4]. A closely related type, *Monascus barkeri* Dangeard, was found to cause spoilage in bottled pickles in America, and is believed to have been introduced into the country from E. Asia, carried with some of the spices used for pickling[5]. *M. barkeri* is used by the Chinese for the manufacture of an alcoholic liquor known as Samsu, similar to Saké, a Japanese alcoholic beverage from rice.

It is, perhaps, possible that the fungus has been introduced into Israel from the Far East, carried with rice, copra, Manilla hemp and other imported agricultural products, and that careful pasteurization normally practised at the Rishon-le-Zion Cellars has in the past kept the fungus from causing trouble in the grape juice industry.

Full details of this work will be given elsewhere.

Grateful acknowledgements are made to Mr. P. S. Rosenthal, Technical Manager of Rishon-le-Zion Wine Cellars, for technical information and for his generous co-operation.

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Figure 1
3 days growth on yeast-glucose agar at 30°C, showing hyphae bearing short chains of conidiospores. (× 133)

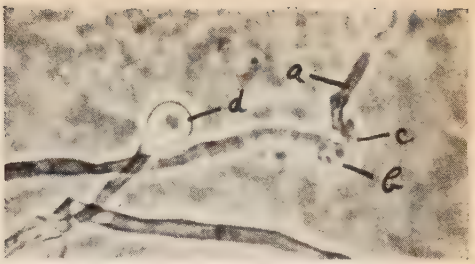

Figure 2
Hyphae terminating in sexual apparatus: a) antheridium, b) ascogonial cell, c) trichogyne. Second hyphae bears d) terminal conidiospore. (× 630)

Figure 3
Perithecium (left) containing a number of immature asci. (× 630)

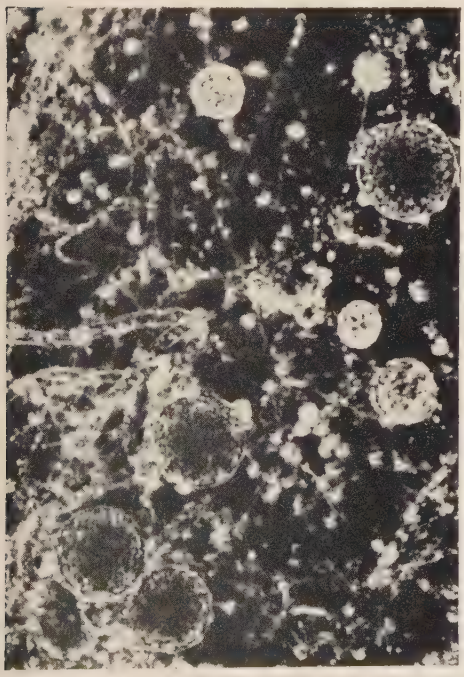

Figure 4
Several weeks growth on grape juice at 30°C, showing a number of perithecia. (× 220)

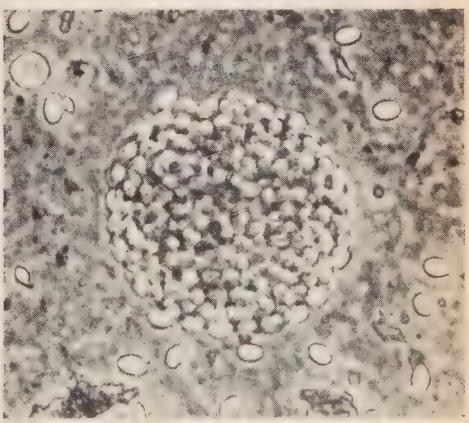

Figure 5
Single perithecium with ripe ascospores. (× 630)

Erwinia rhapontici pathogenic to citrus fruits*

In April 1954, two bacterial organisms were isolated in pure culture on nutrient + 1% glycerol agar plates, from stems of clover which succumbed to a sudden wilting of the plants. The examined plants showed small dark brown spots spreading along the stems.

It was assumed at first that the lesions might be caused by *Pseudomonas syringae* Van Hall, known to be the cause of a leaf and stem spot disease of clover[1]. Hence, the isolated organisms were inoculated simultaneously into unripe citrus and tomato fruits, citrus twigs and leaves, and stems and leaves of clover plants. Later they were also inoculated into avocado, mango, and pepper fruits; collar, stem and leaves of cucumber plants; and onion, cucumber and potato slices in water. Inoculations were made by pricking through drops of a sterile distilled water suspension of 48 hr old slant cultures, or by smearing the twigs, stems and leaves with the suspension after water-soaking them with a fine syringe. The plants, and citrus twigs and leaves were then sprayed with sterile water and kept with the fruits in bell-jars over water at temperatures of 12—37° C.

Though neither of the isolated organisms produced any lesions on clover, one of them was found to be pathogenic to citrus and to a lesser degree to tomato fruits, as well as to onion and cucumber slices. Neither produced infection on any other tested hosts. The lesions on lemon fruits appeared as light brown, slightly sunken hard spots, which turned brown-pink, and were surrounded often by one or two concentric darker rings (Figure 1); they reached a diameter of 0.8 to 1 cm 7—9 days after inoculation at 20—25°C. Infection penetrated deeply into the inner rind which became slightly pink, but did not spread into the flesh of the fruit. Inoculated grapefruit and orange fruits showed slightly sunken, light brown spots, which reached a diameter of 0.3 to 0.4 cm 6—7 days after inoculation at 20—25°C; the flesh of the fruit was unaffected. On tomato fruits, infection was limited mainly to the pricked area and did not spread much further. The lesions appeared as small, dark brown, hard spots, while the pricked area on the control fruits did not show any change of colour or hardening of tissues (Figure 1). An abundant greyish growth appeared on cucumber and onion slices; the former turned pale pink and the latter bright pink. Cucumber slices softened completely within 24 hours at 25°C, while onion slices were only partially soft on the 7th day after inoculation. The optimal temperature for infection was between 20—25°C. Good infection occurred at 14°C, and very slight infection was induced at 30°C. No infection occurred at 37°C.

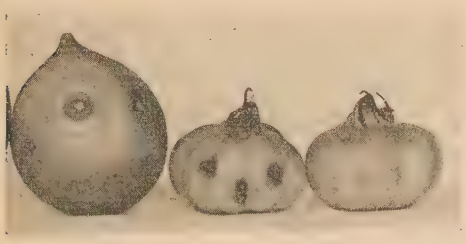

Figure 1
Unripe lemon and tomato fruits inoculated with the clover organism, showing brown-pink sunken spots on the former, and dark brown spots on the latter. There are no signs of infection on the uninoculated tomato fruit.

Infection experiments with reisolations from lesions of all specimens gave similar results. The reisolated organisms were identical with the original isolations. Histological sections showed numerous bacteria in the parenchyma tissue of infected parts. No infection resulted when drops of suspension were not pricked into the fruit. Controls pricked through drops of sterile distilled water did not develop any sort of infection.

Although the clover organism produces lesions similar to those induced by *Ps. syringae* on citrus fruits, it cannot be identified with the latter, nor could it be identified with the genus *Pseudomonas* Migula[2]. Examination of the organism shows that it belongs to the family *Enterobacteriaceae* Rahn, genus *Erwinia* Winslow et al.[2]. One of its main growth characteristics is the frequent appearance of a pinkish colour on nutrient glycerol and potato glucose agar. The organism shows many morphological, physiological and growth characteristics which are similar to those of *Erwinia rhapontici* (Millard) Burkholder[1,2], or of *Bacterium rhaponticum* (Millard) Dowson[3,4], the causal organism of a crown rot of rhubarb which rots onion and cucmber (but not potato) under laboratory conditions, often with the appearance of a pinkish colour[4,5]. This organism, however, is not reported to be pathogenic to citrus fruits[1].

In order to determine whether the clover organism should be identified with *E. rhapontici*, a culture of the latter organism sent from Cambridge was examined, and pathogenicity tests were carried out on citrus and tomato fruits, and on onion, cucumber and potato slices. The results show that the two organisms are closely related

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in their morphological growth and physiological, as well as pathological, characteristics. There are, however, a number of slight differences: the rhubarb isolate, though definitely pathogenic to citrus fruits, causes less extensive lesions on lemon fruits (Figure 2) than does the clover orga-

Figure 2
Unripe lemon fruit inoculated with *E. rhapontici*, showing brown-pink spots; no infection on the control.

nism; it does not produce infection on tomato fruits; it produces complete softening of onion slices; and its thermal death point is slightly lower. On the basis of these differences the clover organism was identified as a strain of *E. rhapontici*.

ACKNOWLEDGMENT

The author wishes to express her thanks to Dr. W. J. Dowson for providing a culture of *E. rhapontici*, and for his helpful suggestions with regard to the identification of the organism.

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Bacteriological findings in the course of an investigation of infantile gasteroenteritis in Israel

It is generally considered that various strains of *Escherichia coli* are aetiological factors in infantile gasteroenteritis. The strains most frequently recorded (and also found in Israel) are serotypes 0-111 B:4, 0-55 B:5, 0-26 B:6[1].

During 1954 two more pathogenic strains were found in Jerusalem, serotype 0-86 B:7 and 0-114. The former, previously recorded from Europe and America [2,3,4,5], was isolated in Jerusalem from three severe cases of infantile gasteroenteritis, of which two were fatal. In one case the organism was isolated simultaneously from the pharynx, faeces and blood. A detailed bacteriological and pathological report will be given elsewhere.

The strain *E coli* 0-114, previously isolated in England by Taylor, was found in 5 cases in Jerusalem. This strain seems to be pathogenic because it was found in material from 127 diseased children and was not present in 470 healthy children (who were examined simultaneously).

In addition, strains of doubtful pathogenicity belonging to the Providence and the Bathesda-Ballerup group were found both in healthy and in sick infants. Similar strains were reported by Henig[6] from the Petah Tiqva area.

TABLE I

Strains of doubtful pathogenicity isolated in Jerusalem from diseased and from healthy infants

Group	O-group	Number of strains isolated		
		Total	From healthy infants	From diseased infants
Providence	0— 1	1	—	1
	0— 2	2	1	1
	0—16	6	3	3
	0—17	1	1	—
	0—23	1	1	—
Bethesda-Ballerup	0— 4	5	3	2
	0—30	3	0	3

In addition, all samples of faeces and pharyngeal swabs were examined for *Micrococcus pyogenes*, and very considerable variations in its distribution among healthy and diseased infants were found.

TABLE II

Positive cases of Micr. pyogenes

	Healthy infants	Diseased infants	X2	P
Faeces	36 (28.2 %)	15 (3.2 %)	80.0	0.001
Faeces and pharynx	13 (10.2 %)	2 (0.4 %)	39.4	0.001

Nine-hundred milk samples from dealers were tested for pathogenic agents. A strain of *E. freundii* was isolated (among other enteric pathogens) and proved to be entigenetically related to *E. coli* 0-111. Such a strain has already been isolated in Colombo (Ceylon)[7] and in Paris[8], from infants with gasteroenteritis. Five strains from milk were identified by Moeller[9] as belonging

to the genus *Hafnia*, a newly established genus of the Enterobacteriaceae which is not considered pathogenic.

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NEWS AND VIEWS

International Committee of Agricultural Librarians and Documentalists

At a meeting in Frankfurt, March 1955, attended by agricultural librarians from seven countries and F.A.O., preliminary arrangements were made for the formation of this *Committee*, with the purpose of reviving and extending the work of the pre-war Comité International des Bibliothécaires Agricoles. Plans were made for the holding of an International Congress of Agricultural Librarians and Documentalists on 10 and 11 September, 1955, probably at the Rijkslandbouwhogeschool at Ghent, at which the formal constitution of the *Committee* is to be followed by papers and discussion.

Anyone interested in making contact with the *Committee* is invited to write to one of the following addresses: Dr. S. v. Frauendorfer, Hochschule fuer Bodenkultur, Vienna 18/110, Austria; Mr. Th. P. Loosjes, Centrum voor Landbouw, documentatie, Rijksstraatweg 1A, Wageningen-Holland; Mr. D. H. Boalch, Rothamsted Experimental Station, Harpenden, Herts., England.

Tenth International Congress of Entomology

The Tenth International Congress of Entomology will be held in Montreal on August 17—25, 1956.

The sections of the Congress have been arranged provisionally as follows: 1) Systematics, 2) Morphology and Anatomy, 3) Physiology, 4) Behaviour, 5) Ecology, 6) Geographical Distribution, 7) Genetics and Biometrics, 8) Palaentology, 9) Arachnida and other land Arthropods, 10) Agricultural Entomology, 11) Forest Entomology, 12) Medical and Veterinary Entomology, 13) Stored Products Entomology, 14) Biological Control, 15) Apiculture.

All those hoping to attend the Congress and wishing to obtain further information should communicate as soon as possible with the Secretary, Mr. J. A. Downes, Division of Entomology, Science Service Building, Ottawa, Ontario, Canada.

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The following notation should be used:

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3. TAYLOR, G. I., 1932, *Proc. R. Soc.* London, **A138**, 41.

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4. JACKSON, F., 1930, *Thermodynamics*, 4th ed., Wiley, New York.

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